July 1982

Price $2.50

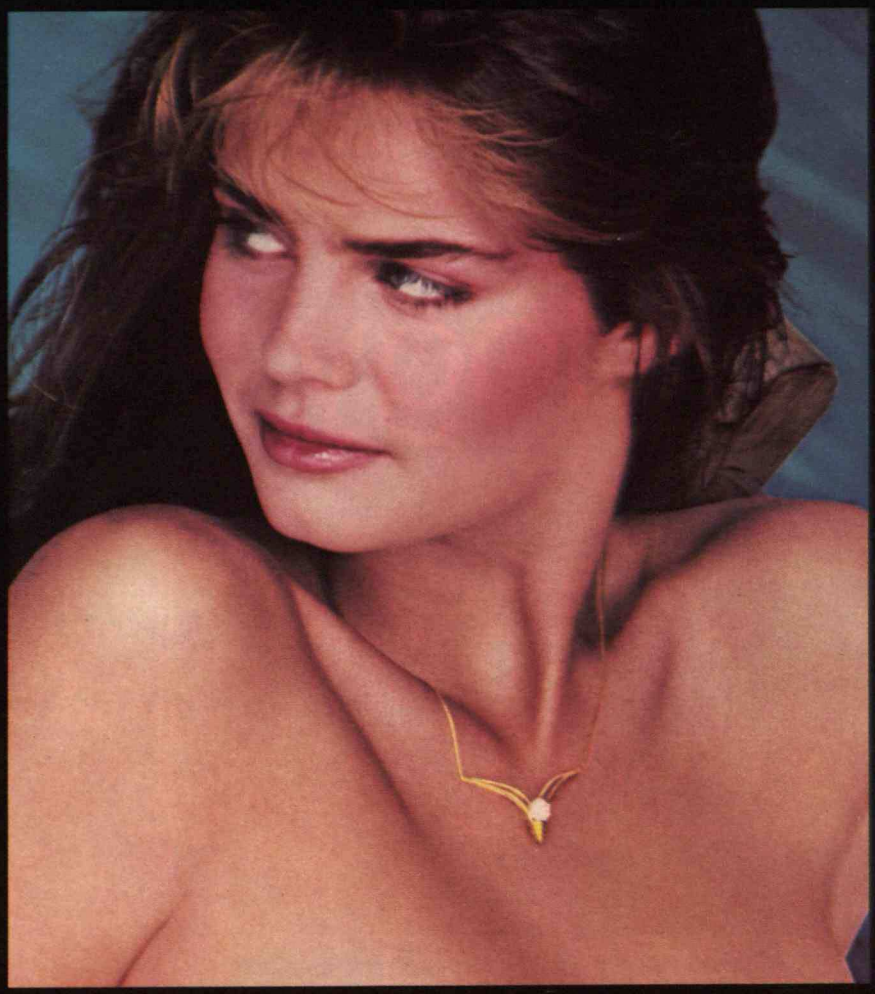
Contaminated Groundwater
Microelectronics: The Edge in the Arms Race
Plants That Feed Themselves
A Lab for All Seasons

Technology Review

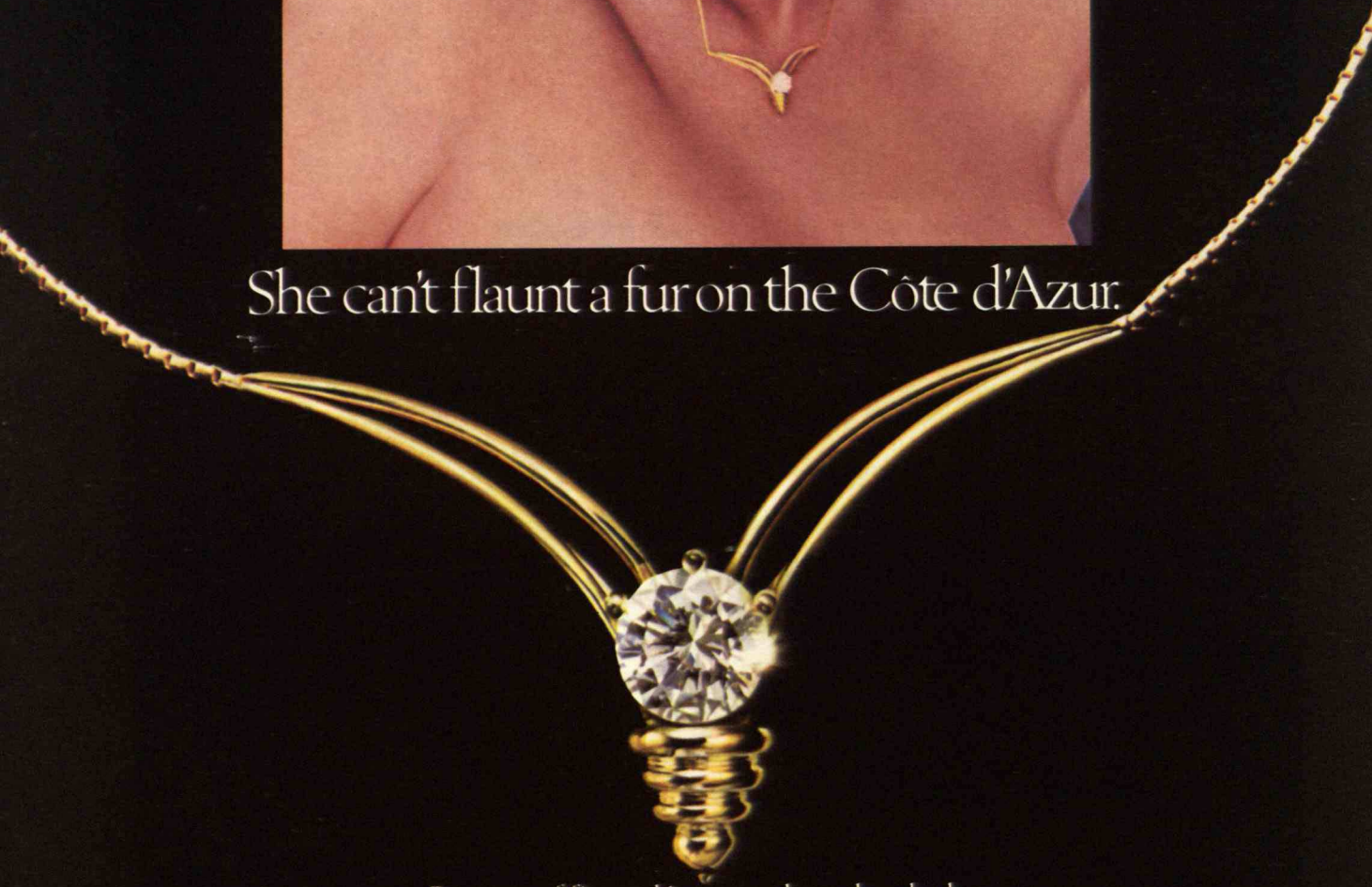
Edited at the Massachusetts Institute of Technology

Human Scales for Urban Spaces

technology
review
Published by MIT



She can't flaunt a fur on the Côte d'Azur.



Born out of fire and ice more than a hundred
million years ago. Every diamond is unique.
But a diamond of one carat or more is even more precious.
A gift so rare, it can never be measured.
Until you see the look in her eyes.

THE DIAMOND SOLITAIRE.
A RARE GIFT.

The one and a quarter carat diamond pendant shown is enlarged for detail.

A diamond is forever. De Beers

Edited at the Massachusetts Institute of Technology
Volume 85, Number 5
July 1982

Technology Review

FEATURES

Small Space Is Beautiful: Design as if People Mattered
Page 36

Cover by Michael G. Cobb
Design by Nancy Cahners

TRENDS

COLUMNS

DEPARTMENTS

Technology Review

Publisher
William J. Hecht
Editor-in-Chief
John I. Mattill
Managing Editor
Steven J. Marcus
Senior Editors
Tom Burroughs
Marjorie Lyon
Ellen Ruppel Shell
Associate Editors
Sandra Hackman
Sandra Knight
Design Director
Nancy Cahners
Production and Design Manager
Kathleen B. Sayre
Production and Editorial Assistant
Valerie Kiviat
Business Manager
Peter D. Gellatly
Circulation and Marketing Manager
Evelyn R. Milardo
Subscription Service Manager
Dorothy R. Finnerty
Assistant to the Editors/Permissions
Elizabeth Motzkin
Circulation and Marketing Assistant
Beth S. Cantor

Technology Review advertising is represented by:
The Leadership Network:
Robert Sennott, Suite 321, 230 Park Ave.,
New York, N.Y. 10017 (212) 682-4500
Larry Benson, Laurence F. Benson Co.,
1411 Peterson Ave., Park Ridge, Ill. 60068
(312) 692-4695
Littel-Murray-Barnhill:
William T. Anderson, 1328 Broadway,
New York, N.Y. 10001 (212) 736-1119

Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October, and November/December) at the Massachusetts Institute of Technology. Two special editions are provided for graduate (pp. A1-A32) and undergraduate (pp. A1-A32 and B1-B16) alumni of M.I.T. Printed by Rumford National Graphics, Concord, N.H. Second-class postage paid at Boston, Mass. and additional mailing offices. Postmaster, send Form #3579 to M.I.T., Room 10-140, Cambridge, Mass. 02139.

Inquiries regarding editorial contents and advertising should be addressed to *Technology Review*, Room 10-140, M.I.T., Cambridge, Mass. 02139. Telephone (617) 253-8250. Unsolicited manuscripts are welcome, but no responsibility for safekeeping can be assumed.

Price: $2.50 per copy. Back issues are $4 ($5 Canada and foreign). Single back copy sales must be prepaid. Subscriptions: U.S.: one year, $18; two years, $36; three years, $54. Canada: one year, $25; two years, $50; three years, $75. Foreign: one year, $32; two years, $64; three years, $96. Send information regarding subscriptions, back issues, and reprints to Reader Service. Allow at least 6 weeks for address changes and provide both old and new address. Claims for issues lost in transit must be dated within 60 days (domestic) and 90 days (foreign) of issue.

Technology Review is a member of ABC

FIRST LINE

Engineering Our Priorities

As many as 2,000 positions on U.S. engineering faculties are unfilled and engineering enrollments are at their highest levels in history. The result, according to Edward E. David, Jr., president of Exxon Research and Engineering Co., will be "serious erosion" of educational quality just when the U.S. needs all the technology it can get to meet aggressive foreign competition.

The assessment by those at the National Engineering Action Conference in New York City early this spring—an effort by Dr. David to bring professional and industrial resources to bear on the problems of U.S. engineering schools—is that the profession is literally trapped by its own success: the rapid growth of high technology has brought increasing demand for engineers and rising salaries. The high salaries have attracted students to the field in record numbers and lured their would-be teachers to industry, as inflation-pressed universities are unable to match industrial salaries. Meanwhile, new technologies have rendered much of the universities' laboratory equipment obsolete, and federal support for its renewal has been terminated.

From the conference came some significant new visibility for these problems and recommendations to increase the resources available to engineering education and the efficiency of their use. Some of these suggestions can be implemented quickly—exchanges between industries and universities to increase the professional opportunities for teachers and bring practicing engineers into classrooms, and increased industrial sponsorship of problem-focused research, for examples.

But most suggestions, aimed at persuading more engineering students to become teachers, can be effective only in the long term and tend in the short term to exacerbate industry's shortage of engineers, which is where the problem began. The real issue is to change the nation's fundamental priorities: the U.S. is producing about half as many engineers as Japan but seven times as many accountants and twenty times as many lawyers.—*J.M.* □

Trend-Setting Bicyclist

The name of Leonard A. Phillips, a fixture on the masthead of *Technology Review* since December 1977, is now missing.

Mr. Phillips achieved local notoriety by commuting much of the year to Cambridge by bicycle, a daily round trip of nearly 40 miles. His new assignment as managing editor of *Laser Focus* reduces that trip to perhaps 30 miles. The rider may rejoice, but the reader of *Technology Review* may be forgiven for a different reaction: he was the editor of "Trends" and procurer and editor of many outstanding articles.—*J.M.*

LETTERS

Finding Fault in Human Factors

Joseph R. Egan mistakenly assumes that all U.S. nuclear plants have the same labor structure as his former workplace in "To Err Is Human Factors" (*February/March, page 22*). I now deal directly with licensed operators for 12 plants, and in each case the supervisors operate the controls as well as direct those operations. These two non-union positions are filled by competent people who command the respect of their former peers after years of experience.

Mr. Egan paints a dim picture of an entire industry when the problem is local.
James E. McDonald
West Suffield, Conn.

Mr. Egan is right in noting that human-factors practitioners generally emphasize hardware design rather than personnel or organizational characteristics. This is because improvements in the system hardware are generally more permanent and less expensive than improvements in personnel selection, training, incentives, and morale. However, improving only the hardware is akin to looking for a lost wallet under the street lamp where the light is better, rather than where it could have been dropped. The article performs a valuable service in reminding us that much of the uncertainty is on the human side of the human-system interface. It remains to be seen whether rational changes can be made

in the areas rightfully labeled "political."
Edwin Cohen
Binghamton, N.Y.

Joseph Egan responds:
My article is not an attempt to illuminate only the human side of the human-system interface. On the contrary, I believe that the present human-factors equation is entirely flawed as an approach to solving safety and efficiency problems in nuclear plants. The human-factors approach diverts attention from more substantive social, political, and ideological realities of the American system of production.

I do not suggest that highly paid behavioral consultants pay heed only to worker psychology, incentives, training, and morale. This they do now. The problem is that their co-opted objectives reflect a greater concern with control of labor than control of "human error," which is being ignored or, even worse, nurtured. What I propose is a much simpler task that begins with a dialogue between engineers and union workers.

Quantity of Information and the Quality of Life

Miles Orvell in "Screen Revolution" (*February/March, page 40*) alludes to people's reverential attitude toward technology "not as a tool for progress but as progress itself." This belief implies that technology is good and therefore that its products are useful, whether they be videotapes, home computers, 24-hour television, or space travel.

Unless worthwhile social visions and political philosophies direct the use of most technologies, the public will be alienated and will turn against not only a particular technology but against Technology itself.

Despite the increased availability of information, management of vital issues such as international relations, economic policy, and political leadership has not changed for the better; if anything, it has gotten worse. Neither understanding nor perception of these vital issues has improved.
Kris Murthy
Kingston, Jamaica

A Book, Not a Tract

I am distressed by Ellen Williams' review of *The Soul of a New Machine* by Tracy Kidder (*April, page 14*). Ms. Williams feels that the author ought to have expressed certain "moral and ethical concerns," and she suggests that Mr. Kidder promised silence on such "touchy topics" in exchange for access to the inner workings of Data General.

As editor of the book, I received constant reports on the author's research and was fully informed of his negotiations with the company. I can assure Ms. Williams that no bargain of the sort she imagines was struck. To suggest that a writer would compromise his integrity this way is a very nasty charge.

As for the "moral and ethical concerns"—they are all there, as countless readers have discovered, and as Ms. Williams will too, if only she reads *The Soul of a New Machine* as a book, not a tract. What she calls "abdication of interpretive responsibility" others call art.
Richard Todd
Cambridge, Mass.

Ms. Williams replies:
I can respond to Mr. Todd's distress about my review with some sympathy, but less than complete comprehension. He seems to have two main complaints. The first is that I have charged Mr. Kidder with striking an unsavory bargain to write his book. I did not make, nor did I intend to make, such a charge. However, I did observe that Mr. Kidder had not provided the essential facts that would preclude such speculations.

Mr. Todd goes on to complain that I abdicated my responsibility to "look into the facts," the very ones whose absence I deplored. I accept Mr. Todd's assurances that Mr. Kidder did not "compromise his freedom," but persist in suggesting that it is the author's responsibility to provide those assurances (and, incidentally, the facts of the negotiations) to all readers.

As for the second complaint, no doubt others may likewise consider the omission of pertinent facts a matter of art. Divergence of opinion is the lot in life of both artist and book reviewer, and certainly the *raison d'etre* of the latter. In suggesting that I read *The Soul of a New Machine* "as a book, not a tract," I gather Mr. Todd means to fault my reading rather than Mr. Kidder's writing or his own editing. That, I acknowledge, is his prerogative.

Risk Analysis in Congress

Samuel C. Florman (*"Risk Analysis and the Congressman-Engineer," February/March, page 12*) completely misunderstands the intent and the character of my legislation. He says the legislation attempts to have risk assessment become a "mathematical sieve" through which all regulatory decisions would be forced. In fact, the legislation seeks to mandate the use of risk evaluation as one of the many tools in regulating hazard. The final regulatory decision will always be a complex political, social, and economic one, but is it too much to work toward scientific input greater than zero?

Furthermore, Mr. Florman fears I would bring "a uniform mathematical standard" to the political process. I'd like to calm those fears. I am sure Mr. Florman knows that there are no standards or consistency—let alone mathematics—in that lively process.

For someone like Mr. Florman, who has warned us not to look under stones for mythological demons in technology, isn't a little more science reasonable? Does my venturing out from the safety of academe and engineering consulting into the political wars deserve being branded "a disservice to my profession?" Admittedly, politics has its thorns and I welcome Mr. Florman's challenge; indeed, spreading the word about regulating risks is worth even the pain of published misunderstanding.

Mr. Florman exhibits a fundamental misunderstanding of the Washington scene. It is an unintended compliment to me that somehow the one lonely engineer in Congress could take a piece of science-based legislation and push the entire regulatory process for health, safety, and environment right through it.

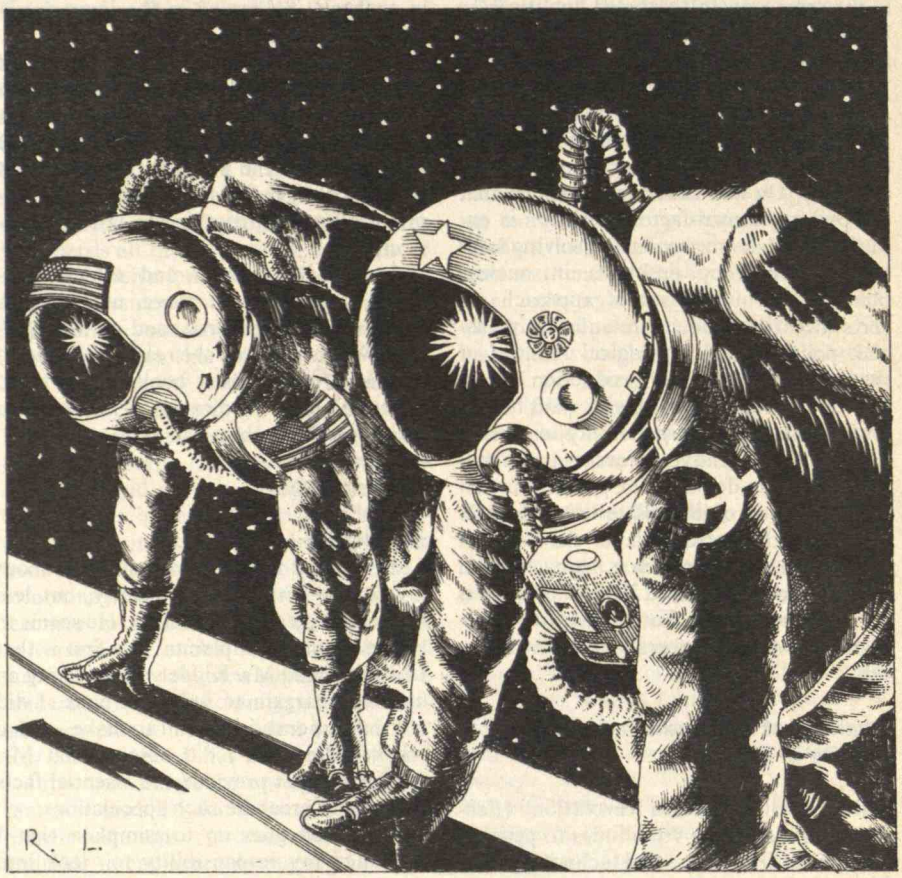
We can gain a better perspective on technological hazard through a sprinkling of scientific wisdom. Why resist it?
Don Ritter
Washington, D.C.

Mr. Ritter is a member of the House of Representatives from the 15th District of Pennsylvania.

Mr. Florman responds:
Let me quote a press release issued by Rep. Ritter's office, adding emphasis to the words I find particularly disturbing: "The congressman's legislation *requires* all federal regulators to make risk comparisons when they consider controlling, banning, or restricting something that could be a potential hazard. . . . They *must* compare the risks between the product or process they want to regulate and its alternatives. . . . They *must* compare the risks among different levels of regulation. . . . They *must* explain the risks they are seeking to regulate in comparison with everyday risks that people can understand, such as the risk of smoking or driving."
(*Continued on page 22*)

Robert Cowen

Slowed Pace in the Space Race



ROGER LEYONMARK

At this writing, the U.S. space shuttle had completed three test flights and was about to undergo a fourth. If that is as successful as the first three testings, the shuttle will begin to take up its destined career as an earth-to-orbit-and-back workhorse. And there is plenty of work for it to do, with some 68 more flights scheduled through September 1987. These include 25 military missions, many launches of commercial and scientific satellites, several missions with the European Spacelab orbiting laboratory, and perhaps an attempt to repair the ailing Solar Maximum Mission satellite. Among the scientific payloads will be an advanced gamma-ray observatory and the large space telescope.

With so much exciting activity already planned, it may seem a bit churlish to suggest that Americans might pay more attention to what the Russians are doing. After all, if the U.S. media paid as much attention to the broad-ranging Soviet space effort as they do to the contracting U.S. program, it might dim some of the shuttle's glamour. But since no less a shuttle booster than James M. Beggs, administrator of the National Aeronautics and Space Administration (NASA), would probably agree with that statement, it may not be so churlish after all.

Mr. Beggs has himself expressed a wish for a brighter spotlight on Soviet space efforts. He thinks it might stimulate more support for the U.S. space program. It's not just that the Soviets are maintaining a strong solar-system exploration effort while the U.S. has all but abandoned the planets, to say nothing of Halley's comet. It's not that the Soviets routinely launch several times as many spacecraft per year as the rest of the world combined. And it's not that they've just put into orbit the central unit of a permanently manned space station. What is even more important is that Mr. Beggs and his advisors share with the Soviets the conviction that the 1980s are the decade of the space station, the decade in which to establish a permanent manned presence in orbit.

Shuttlebutt

The United States wants easy access to low-earth orbit, and it is getting it with the shuttle. This impressive Space Transportation System, to use its official name, will be an important tool for accomplishing U.S. space objectives, including building a space station if such a project is authorized. But the more successful it is, the more the shuttle will be an embarrassment to NASA and the more Mr. Beggs or his successor will likely try to turn it over to industry. "NASA," says Mr. Beggs, "is not an operating agency. We are in the research and development business, and I would hate to fill this agency with operating kinds of people who are dedicated to the job of flying something routinely."

By 1985 or 1986, when the shuttle should be ready for such a handover, Mr. Beggs believes NASA should be deeply involved with its first space station. To this end, the agency is holding discussions with Canada, Europe as represented by the European Space Agency (ESA), and Japan, all of whom have expressed strong interest in joining an international space-station project with the United States. NASA is also doing battle within the administration to convince such skeptics as presidential science advisor George A. Keyworth of the value of such an undertaking. Thus it is little wonder that Mr. Beggs would like more publicity for the Soviets. And indeed it is useful to view the U.S. program in light of the Soviet effort.

The broad-ranging Soviet effort continues to include a strong solar-system program along with military, commercial, and—most impressively—manned space stations. The landings on March 1 and 5 of *Veneras 13* and *14* were stunning feats. These automated craft returned the first color photos of the Venus surface as well as the first chemical analyses of surface material. The U.S. Geological Survey reportedly was hurrying to get copies of the Soviet data tapes before the U.S.-Soviet space research agreement ran out May 24. It was not renewed because of U.S. displeasure with Soviet pressure on Poland. Four more Veneras had been scheduled to go to Venus in 1984. But two were retargeted to visit Halley's comet upon its return in 1986 after the U.S. decided it couldn't afford a Halley's mission.

Soviet Space Fitness

The vigor of the Soviet program shows up in launch statistics. Last year, NASA had 17 launches. They included 13 communications, navigational, and weather satellites of customers outside the agency; two scientific satellites; and two shuttle test flights. This year, around 16 launches are expected. These will again be mainly launch services for foreign and domestic customers, plus three shuttle missions. In addition to NASA activity, the Department of Defense annually conducts a few launches of its own.

Meanwhile, 1981 was a typical year for the Soviets, with 98 launches that orbited some 125 separate payloads. These included military, weather, earth resources, communications, and scientific satellites and four missions to the *Salyut-6* space station. Three manned craft and one unmanned supply ship docked with that station, which was officially declared to be retired after four year's service. "We are taking a break to design a new station," said Salyut official Aleksey Yeliseyev. "We are ready to make the next step—to graduate to the creation of permanent orbital complexes," said Leonid Brezhnev.

Western experts, including Mr. Beggs, say that they believe the Soviets are ready to back up such pronouncements with action. Their station will be a modular structure, with a central unit joined by other large specialized units as needed. For example, an astronomical observatory with its own power supply could dock with the central unit for an extended astronomical mission. The station will likely be able to accommodate up to 12 cosmonauts at a time, depending on the specific missions and the configuration of the station. However, some cosmonauts would be on board at all times.

After its retirement, *Salyut-6* was visited by the unmanned *Cosmos-1267*, which undertook orbital maneuvers of its own and sent back a reentry vehicle. This looked as though it was a test of the modular space station concept. As some Western observers expected, the central unit of the new *Salyut-7* station was launched this spring.

Meanwhile, the Soviets are believed to be developing a large booster rocket and some kind of shuttle. The booster would be in the class of the old U.S. *Saturn-5* moon rockets. However, the shuttle, while it could land on a runway, probably would not be a large reusable craft like that of the U.S. Rather, it likely would be a small unit to return people and equipment from the Salyut station. Some Soviet officials have said they do not foresee the need for a U.S.-type shuttle in this decade. However, for what it is worth, Anatoliy Y. Skripko, science and technology attaché at the Soviet embassy in Washington, did tell a meeting of the American Astronautical Society in March that a Soviet reusable shuttle would be launched in about five years. He said it is indispensible for supporting large space stations.

This, then, is the Soviet effort that Mr. Beggs wishes were more visible to the U.S. public and the rest of the Reagan administration. For its part, NASA already has several designs of space stations underway. These include an orbiting space operations center—a kind of Mission Control in the sky. It is unclear whether this should be a joint military-civilian center or the military should have its own. Certainly it would be awkward to try to accommodate the military in any international space station.

Space-Station Marathon?

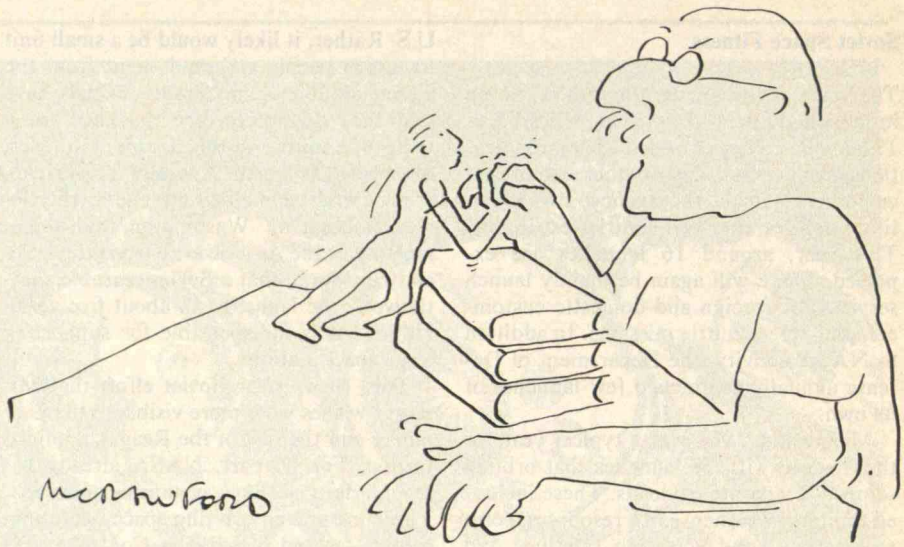
There is undoubtedly going to be a major political debate over the long-range goals of the U.S. space program. Taking on an expensive new project such as the space station right now is not appealing to the administration, or probably Congress. Dr. Keyworth, for one, has said publicly that he "finds it difficult to support a space operations center." However, convinced that construction of space stations is inevitable, Mr. Beggs and his supporters are ready to do battle for their cause. Among other things, they can undercut objections to the cost of such an undertaking by showing that Canada, Europe, and Japan are willing to share it.

This issue will probably be decided on political grounds by the president himself, as was the case with the Apollo moon landing program. Although it hasn't yet caught the eye of the mass media, which is bemused by the shuttle, the U.S. may within a few years have an imaginative new space goal that will be as demanding as the moon landing program. But this time one hopes that the hardware sent into space will have an ongoing utility. □

Robert C. Cowen is science editor of the Christian Science Monitor *and former president of the National Association of Science Writers.*

Samuel Florman

Technological Literacy: An Uneasy Victory



MICHAEL CRAWFORD

THERE are contests it is sometimes better not to win—an argument with a spouse, a game with a young child, a round of golf with a customer. There are also times when one fights with all one's heart for a cause, only to discover on the brink of victory that satisfaction over the pending outcome is tinged with regret. I have been thinking along these lines as I view the engineering profession's battle for a place of honor within the academic community.

In December 1971, the Alfred P. Sloan Foundation announced a new program—The Social Dimensions of Engineering Practice. The attitude of Americans toward technology had been souring for a number of years, and with the onset of the environmental crisis in 1970, engineers were everywhere on the defensive. The times seemed to require engineers who could understand the cultural and social implications of their work, and who could cope with the rapidly changing political and economic environment in which they would have to make their careers.

The Sloan trustees confronted the question of how to educate such engineers and decided upon a new and imaginative course. They invited a number of the nation's leading engineering schools to apply for grants to support experimental interdisciplinary activities.

This social-dimensions program ran from 1972 to 1977, during which time the foundation gave almost 9 million dollars to 23 institutions. The money was used mostly to create new courses, more than 200 in number, with titles such as "Technology and Human Values," "Interaction of Public Policy with Technology," and "Environmental Issues and Problems." In this endeavor hundreds of engineering faculty members worked jointly with faculty from the social sciences and, to a lesser extent, law and the humanities.

The survival rate of the new courses, according to a recent Sloan report, is not very high, and as for the interdisciplinary teachers, most have returned to their regular assignments. Still, the program was deemed valuable in inspiring interaction between engineering and other academic disciplines and in introducing technology into mainstream liberal education.

I agree that the effort was worth making, however ephemeral the results. However, there was one aspect of the program that the Sloan people found "surprising and disappointing": the newly developed courses appealed mostly to nonengineering students. In other words, "The Social Dimensions of Engineering Practice," instead of improving the education of engineers, revealed a growing interest in technology among students in the arts and sciences.

This discovery must have been on the minds of the foundation officers and staff as they deliberated about their latest major program, "The New Liberal Arts." In March of this year, 30 liberal-arts colleges were invited to apply for grants aimed at making applied mathematics and technological literacy an integral part of their curricula. According to the letter of invitation: "Any attempt to meet the purposes of the program will almost certainly entail instruction intended to create 'computer literacy.' "

The turnabout here is breathtaking. Having given up on the idea of creating humanistically sensitized technologists, the foundation has decided to create technologically sophisticated humanists. Apparently despairing of making changes in the large technical institutions that are turning out tens of thousands of engineers each year, they intend to implant technology in small, elite institutions where it has traditionally been ignored if not actually disdained.

The concept of technological literacy for everyone is surely admirable, but the new program, particularly when viewed in conjunction with the termination of the old one, strikes me as being vaguely ominous. I shouldn't feel that way, I know. For many years, I—along with other engineers—have proclaimed the intellectual and spiritual worth of our profession and resented the high-handed way so-called humanists have appropriated the word "culture" for themselves. Yet, on the verge of what looks like a significant victory for our side, I become uneasy.

Not So Liberal Arts

The action taken by the Sloan Foundation is only one manifestation of the shift that has been taking place in academe over the past decade. Palpably, engineering has been gaining strength, while the liberal arts have been struggling to come to grips with a changing public mood.

At Ohio State University, for example, over a period of ten years, enrollment in the Colleges of Business and Engineering has doubled, while enrollment in the College of Arts and Sciences has dropped 33 percent. Nationwide the figures are not that dramatic, but to students facing financial pressures and sensitive to a swell of no-nonsense, conservative national sentiment, engineering looks more and more like a prudent career choice.

Just this year the Reagan administration has proposed cutting support for the arts and humanities by nearly a third while maintaining support for scientific research (and dramatically increasing research funds for the Department of Defense). I recently visited a prestigious Eastern university and heard the dean of engineering tell an alumni group that as his department

(Continued on page 22)

In Defense of Quality

Considerations of the federal budget, when they get around to defense spending, tend to reignite the debate over quality versus quantity in military hardware.

Within the funding available for defense procurement, is the nation better off buying larger numbers of simpler aircraft, missiles, tanks, and ships? Or are national defense and security better served with fewer units of equipment that's more advanced technologically and provides greater performance and capability? Such equipment is necessarily more costly, for the same reason that a 10-speed bike costs more than a 3-speeder.

The advocates of quantity argue that sheer numbers count for more in combat than the quality of the hardware. The central flaw in this contention is that low-technology weaponry in many cases cannot do the job in our high-technology times.

Take fighter aircraft as an example. To be sure, there are combat arenas where large numbers of less advanced fighters could deliver better results than smaller numbers of more sophisticated and expensive planes. But the reality of aerial combat is that conditions are generally less than ideal. They are unlikely to be suited to the use of simpler planes. Wars aren't always fought from 8 to 5 with crystal skies.

What about nighttime operations? Adverse weather? The need to penetrate enemy defenses? In the face of such demands, the test of combat could not be met by planes that are blind in the dark or murk and are armed with visual-range missiles. What these missions require are high-performance aircraft equipped with electronics to see and sense things their crews cannot, and weapons that can find and destroy targets even when they're shrouded in darkness or clouds.

Similar failings apply to ground-based and seagoing equipment that's simpler in design and ability and hence less costly:

- tanks too lightly armored to stand up to the pounding of enemy fire;
- ships lacking electronic brains, eyes, and ears for long-range surveillance and strike;
- carriers incapable of launching powerful attack aircraft;
- submarines without the range and endurance provided by nuclear propulsion.

Austere weaponry certainly has a place in America's defense arsenal. But it cannot substitute, whatever its quantity, for equipment delivering the greater performance and versatility made possible by electronics and other advanced technologies.

The Soviets' military production is awesome. They spend 15% of their gross national product for military purposes, compared with 6% for the U.S. Last year they built five times as many fighters and fighter-bombers as the U.S., seven times as many armored personnel carriers, five times as many tanks, three times as many ICBMs.

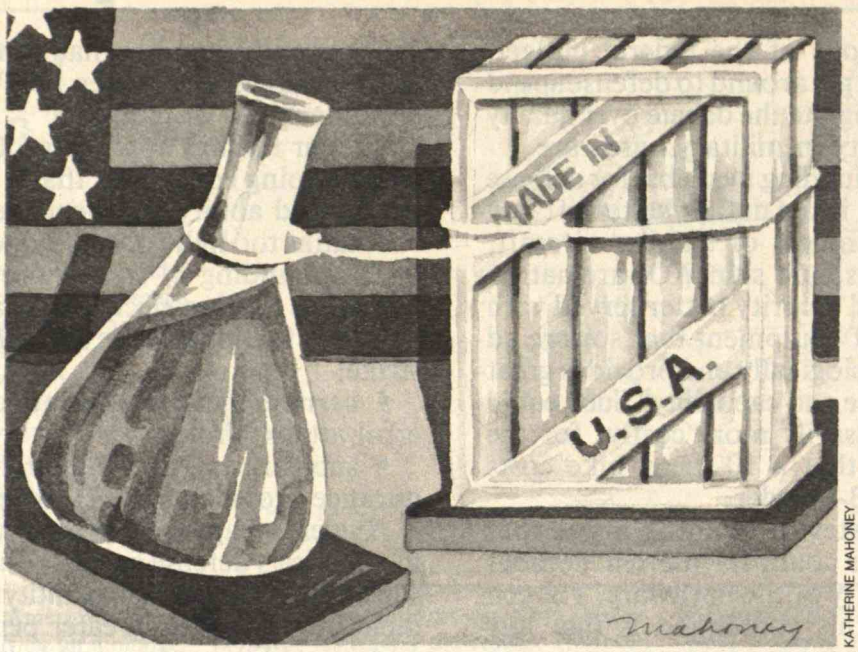
At this time, there is no way the U.S. can match the Soviet Union in *quantity* of weaponry. Where we must excel is in *quality*. We must design and build into our equipment the highest useful quality and capability that technology can provide. (Even so, that shouldn't mean "gold-plating," or overdesigning to deliver unneeded performance at great cost.)

When American lives and security interests are at stake, second best isn't good enough.

The Goal of U.S. Science Policy

by George A. Keyworth II

A priority of President Reagan's administration is to strengthen the American economy. To do that, we must govern in a way that encourages a resurgence of international competitiveness by U.S. industry. This objective requires both a strong science and technology base and effective means of linking that base to innovation and productivity. The U.S. is the undisputed world leader in science. Our industry can be restored to the same position of world leadership if we provide the proper economic environment.



KATHERINE MAHONEY

This loss of international competitiveness is relatively recent, but it has been brewing for years. We paid insufficient attention to the maturing of European and Japanese industries in the post-war years. Their rebuilding, speeded by generous U.S. assistance, now gives them competitive parity with U.S. industries in many cases. The result: foreign high technology in our own homes and garages.

Historically, the United States has been committed to using technology to multiply human labor—that is, to increase productivity—and we reaped the harvest in our enviable standard of living and strong sense of national security. But this multiplication of labor has slowed in recent years.

Why? As a nation, our increasing standard of living and sense of security focused attention more on distribution of existing resources than on production of new ones. In turn, we in the science and technology enterprise forgot to concentrate on how to use all the wonderful new knowledge we were gaining. We assumed—wrongly—that knowledge would automatically find its way to the marketplace. We know now that it doesn't, that one must work as hard at using knowledge as at finding it.

So today many of our industries are staggering under the load of foreign competition. We no longer dominate the world market for technology-dependent products, and that has far-reaching consequences on our domestic economy. The blunt fact is that high-technology industries—those with very high research and development components—are critically important to the health of U.S. exports. A decade ago, we could count on high-technology exports to keep our trade balance positive despite large imports of other goods, but not today.

Knowledge to Market

Our nation and economy are based substantially on the fruits of technological progress and the free-enterprise system. So this foreign competitive challenge in high technology strikes near our economic heart; we have no choice but to meet it. The U.S. economic system, of course, is very strong and resilient. What we must do is adapt American institutions and practices to serve our needs better. To do that, we must assess those things we do well.

Basic research is at the top of the list. Our success is a product of our educational institutions, public support, broad access to learning, tradition of independent thought, and mixing of research and teaching. Reflecting this remarkable consistency of excellence, U.S. scientists have won more than half of all the Nobel Prizes since World War II. And in the past ten years U.S. scientists have done even better, winning twice as many Nobel Prizes as the rest of the world's scientists combined.

To me this is evidence of a vital, healthy system of institutions and processes for the pursuit of fundamental research. The heart of excellence in our science enterprise is our institutions of higher learning—and American universities set the standard for the rest of the world.

A major component of our national capacity in science is the long-standing federal commitment to basic research. But this federal interest does not exist in a vacuum; it is stimulated by several concrete national objectives. One is the recognition that long-term research and development create opportunities for economic growth. We have seen time and again how the products of research can, under the right conditions, spawn remarkable new industries, just as the transistor did 30 years ago and as recombinant-DNA technology is doing today.

This practical upshot of basic research convinces most nonscientists of the need for federal support for long-range research. But the government also realizes the value to society of the kinds of truly monumental advances in human knowledge that keep a people's intellectual base vital and pushing at the frontiers. A country that can afford such intellectual exploration—and we can—should make strong efforts to do it.

Turning to Industry

At the same time, I believe that the federal government has not looked very carefully at the kinds of science and technology it has supported. In times of rapid economic growth, the United States could be sure that the best and most productive science and scientists would be supported. However, in the current economic climate, we must exercise somewhat more discrimination in allocating limited resources. Just as there is a clear-cut role for government in the area of basic research, there must be a clear role for the private sector in applying the results of that research. Our nation has thrived on the test-bed of the marketplace, and this administration plans to rely on those marketplace mechanisms in determining how to allocate federal resources.

We also would like to see growth in support of basic research by other Western nations, including Japan. Generation of new knowledge is a necessary, though not

sufficient, requisite for technological progress. But the United States has for too long shouldered a disproportionately large share of that burden. We have watched our trading partners freely take the results of our research and turn them into products that compete successfully with our own. Now that the economies of those other nations are strong, they should join us fully in this effort. There is no reason for us to feel threatened by their increased attention to basic research. Indeed, competition in the search for knowledge should help us concentrate our own efforts on identifying and supporting the best research.

Some of our economic problems will be solved naturally as we rebound from the shock of finding ourselves in the midst of this unfamiliar competitive thicket. The U.S. space age was born in the shock of *Sputnik*. We can expect a U.S. industrial surge as a result of this less sudden but equally shocking recognition of our economic predicament. However, I am not advocating a national policy that depends on such crises for motivation. If we can learn our lesson and start planning for the long-term, we will surely be better off.

Federal Actions

The administration has established a number of programs to create a climate in which industry can improve its productivity and innovativeness. Some tax policies encourage increased industrial support of research and development and investment in capital improvements. Others make it more attractive for industry to support research at universities. And there is a provision in the 1981 tax legislation that encourages investment in new, small, technology-based firms.

The administration has also made a major commitment to reducing the diversion of industrial and public resources to compliance with unreasonable regulations. There is a large opportunity for responsible savings in this area: after all, by some estimates, consumers have been paying more than $125 billion each year because of federal regulations.

The President's Task Force on Regulatory Relief, directed by the vice-president, aims at reducing the regulatory burden through the application of a more rational basis for regulations. In addition, I chair a group working with the heads of five major health, safety, and environmental agencies to improve the scientific basis of the regulatory process. Our first task is to develop principles to guide the agencies in determining the degree to which an exposure to a substance or phenomenon constitutes a human cancer risk.

On the important question of patents, the administration vigorously supports legislation to improve the potential for successful commercialization of new knowledge. We want to broaden and bring uniformity to the automatic assignment of patent rights to the private sector for inventions developed with federal funding. We also want to improve commercialization potential by extending the patent life of those products that require lengthy federally imposed testing, such as drugs or pesticides.

We must remember, though, that the health of our industries—high technology, low technology, and no technology—depends foremost on our overall economic climate. In particular, improved economic growth and lowered inflation will create financial stability. That stability, in turn, will encourage long-term investments in research and thoughtful development of products and processes.

We do face certain annoyances in the international arena. Some other governments actively assist their domestic industries and shelter them from foreign competition. They subsidize new technologies until they can achieve commercial success, and support long-range, market-oriented research and development.

There have been serious suggestions that that United States should also establish such government management mechanisms. I do not agree. Although the problems of the 1980s require that we modify our institutions, we must recognize and build on our American strengths. I don't think anybody wants to see the United States become a "Japan-come-lately."

Remember that the strength of U.S. industry has been its diversity and ability to respond directly to new ideas and opportunities. A good example is the recent burgeoning of new companies developing commercial uses for monoclonal antibodies, a biological discovery described in the scientific literature only seven years ago. Fast-moving commercial phenomena such as this convince me that the advantages of industry running industry clearly outweigh the dubious benefits of ponderous government involvement in industrial direction and subsidization. But this is certainly an area in which we need thoughtful and far-sighted industrial leadership.

One area that does demand government intervention is the seeking of trade parity for U.S. industries. It is simply not compatible with our free-enterprise system to permit foreign industries to export freely to the United States while those countries deny us equal access to their markets. Commerce Secretary Baldrige has been especially forceful in pursuing this issue.

Dollars Talk

The 1983 federal budget for research and development reflects the essence of our science policy as it has developed during this administration's first year. The budget documents the very high priority President Reagan gives to maintaining the strength of science and technology. In a nutshell, federal expenditures for research and development will increase by almost 11 percent over 1982; within that, basic research will increase by 9 percent. These increases occur within a budget severely constrained by the nation's economic problems.

While I am not insensitive to the research community's concerns about funding levels, I feel that we are indeed keeping science healthy. After all, the best work is going to be funded because our system is organized to do just that. In a sense, keeping science healthy is the easiest part of policy formulation. The difficult task is to find ways to put that healthy science to good use. Frankly, without that effective coupling, it is difficult to justify a massive federal role in the broad support of research. This aspect of science policy has been overlooked for too long.

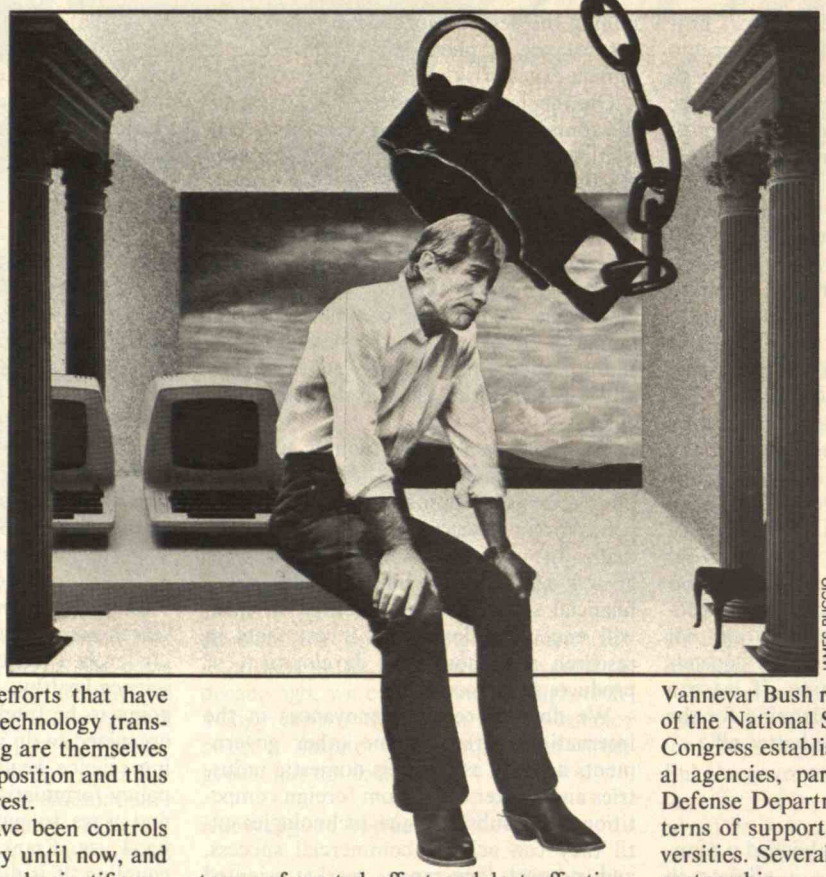
As a nation, we must define a role for government that supports, rather than competes with, our free-enterprise economy—without neglecting those responsibilities appropriate for government. We are aiming for a clear delineation of the limits of government's role. Too often government has sent mixed messages about what it would or would not do in areas of applied research and development. This confusion of responsibilities discouraged private-sector initiative and nothing happened.

These changes don't occur easily. Nonetheless, the reality of the 1980s demands serious reevaluation of the way we develop—and especially the way we use—knowledge in the United States. □

George A. Keyworth II is director of the Office of Science and Technology Policy and science advisor to the president. This article is adapted from a presentation at the American Chemical Society's national meeting in March.

The University Case Against Secrecy

by Paul E. Gray


JAMES PUCCIO

Confronted by increasing commercial competition from Western Europe and Japan in high-technology markets, as well as heightened tensions in relations with the Soviet Union, the United States has taken a new and vigorous interest in controlling the flow of technology outside its borders. There is growing concern in the federal government that the "leaking" of technical material and ideas to other nations impairs national security both by diminishing the ability of the United States to compete commercially and by reducing the country's edge in armaments. Yet specific efforts that have been initiated to control technology transfer in the university setting are themselves likely to weaken the U.S. position and thus do not serve national interest.

Among these efforts have been controls on cryptography, voluntary until now, and on technical information and scientific exchanges. Such curbs have been imposed through the International Traffic in Arms Regulations (ITAR) and the Export Administration Regulations (EAR), and the Department of Defense has proposed restrictions on research carried out under the Very High Speed Integrated Circuits (VHSIC) program.

Some say that universities simply must learn to live with new constraints if they wish to do research in "sensitive" areas. The likely response from many members of university faculties would be a decision not to undertake such research. If this occurs, both the university and the nation will suffer, and there will soon be fewer ideas and developments worth protecting. If the list of sensitive areas is as broadly drawn as Admiral Bobby Inman, former deputy director of the Central Intelligence Agency, has suggested, the United States will be severely damaged.

An alternative approach would be to draw a much narrower list of areas to be protected and to classify all research in those areas, regardless of where it is performed. This would have the advantage of presenting universities with a clear choice. Some appraisal of the potential cost—in terms of wasted effort and lost effectiveness—could also be made, and these costs could be compared with those associated with leakage of the research. But there should be much public discussion before any such regulations are recommended.

World War Brings Secrecy

The idea that university research should be restricted by the government did not take hold seriously until World War II. Before the war, there was little federal involvement in research; the small amount of sponsored research in the universities was supported largely by industry and was usually narrow in scope and oriented toward practical results. But the war involved many scientists and engineers in the application of technology to military purposes.

These researchers, drawn mostly from university faculties and often placed in university laboratories organized for specific military purposes, were deeply engaged in developing microwave radar, high-frequency communications systems, automatic fire-control systems, navigational aids, and jet-aircraft design, to say nothing of nuclear weapons. Their projects were, of course, classified. Secrecy was accepted for the short term as essential to winning the war, and it produced little conflict within the universities at that time—mostly because the paucity of students during those years resulted in a virtual suspension of their educational efforts. Universities, in short, stopped functioning as universities.

During the years immediately following the war, the government and the universities developed arrangements that made possible continued federal support of basic research in university settings. Most of those developments had their roots in a report prepared in 1945 by Vannevar Bush recommending the creation of the National Science Foundation, which Congress established in 1950. Other federal agencies, particularly elements of the Defense Department, also established patterns of support for basic research in universities. Several considerations led to this partnership:

☐ The wartime experience had shown that universities must contribute to basic and applied research, and that university faculties were an enormously valuable national resource.

☐ Basic research was becoming far more complex and costly. Industry viewed it as a high-risk venture, since its benefits were returned primarily to the common account. It was clear that the federal government would have to become its principal patron.

☐ The government had an interest—and the nation a high stake—in the education, through the postdoctoral level, of more scientists and engineers, and the academic environment of the research universities was uniquely equipped to develop these human resources.

As this new partnership developed, the curtain of secrecy that had surrounded government-sponsored university research during the war was lifted. Research in universities was usually performed without limitations on access or on the dissemination of results. This shift to openness, which had long characterized university-based research, was undertaken quite deliberately, and the reasons for it are fundamental to any understanding of the conse-

quences of present restrictive efforts.

The quality and integrity of research are anchored in its nature as a dispersed, interdependent, and cumulative enterprise. Research is dispersed in that work at the frontier in most fields is conducted simultaneously in several locations. It is interdependent in that investigators or groups of investigators rely on work done elsewhere to validate and extend their own work. The closer research is to the frontier of knowledge and the more swiftly a field is developing, the more researchers depend on open and rapid communications with colleagues working on similar problems. This dependence leads to the development of informal networks of communication that include working papers, preprints, and especially personal communications. Although the refereed journals of science become the publications of record, they are not the primary means for communicating innovation.

Research is cumulative in the sense that many small steps by individuals working in many different places and under diverse auspices contribute to new knowledge. Indeed, U.S. leadership in such diverse fields as cryptography and recombinant DNA, for example, has come about precisely because of the open, independent nature of research in American universities. In such endeavors, limitations on the communication of results obviously impede progress. Such secrecy is also very difficult to achieve.

Scientific research is, increasingly, an international undertaking. Talent and creative energy are widely distributed and do not respect political and national boundaries. Thus, world-class research in many fields is conducted in Western Europe, Japan, and the Soviet Union as well as North America and many other places. Furthermore, the faculties and research staffs in most U.S. universities are composed in part of scholars from many other countries. Some are here more or less permanently; others are visitors for a few weeks or a few years. Academic and other institutions achieve prominence in research by focusing—single-mindedly, insistently, and passionately—on attracting and retaining the most creative individuals. This inevitably leads to a cosmopolitan community at all of our great research universities.

These universities are unique in their intimate coupling of education and research. Faculty members engage regularly in conventional teaching as well as research, which itself embodies many of the essential elements of teaching in a less formal setting. Both undergraduate and graduate students do research, contributing the enthusiasm and intellectual energy of youth and the special advantage of not knowing that "it cannot be done that way." Curricula are revised and kept current by the steady infusion of ideas developed in research laboratories.

The complete enterprise is much more than the sum of the parts, education and research, and the resulting synergism is a major factor in the outstanding achievements of academic scientists in the United States. Any effort to decouple education and research will diminish both activities and weaken our national position.

Concern in Academia

These characteristics of scientific and technical research influenced the U.S. postwar decision to reestablish research in universities in open settings. Universities and the federal government developed an understanding that basic scientific research not directly related to the national security would be undertaken in an unrestricted environment. As part of this understanding, universities have undertaken classified research only after careful and detailed consultations with the government on both the need for the research and its scope. Such research is usually carried out at sites separated from the university campus and isolated from the normal academic environment and process.

After-the-fact classification of research results has been rare. This pattern was developed not to indulge dour academics, but out of a shared understanding of the quality and effectiveness of research conducted in an open environment.

An underlying premise of this shared understanding was that, except for classified research, the traditional academic freedoms of inquiry, teaching, and publication would not be abridged. A university or its research faculty may agree by contract to a system of prior review, of course, but unless such an agreement is in force, there remains a constitutionally protected right of publication. And the progress of science has clearly been advanced by this basic First Amendment protection.

Out of a growing concern that this shared understanding is being damaged by attempts to apply the arms and export regulations to university-based research, the presidents of five universities—the California Institute of Technology, Stanford University, Cornell University, the University of California system, and M.I.T.—wrote in early 1981 to the secretaries of commerce, defense, and state to express their concern about this issue. The letter said in part:

"The new construction of these regulations appears to contemplate government restrictions of research publications and of discourse among scholars, as well as discrimination based on nationality in the employment of faculty and the admission of students and visiting scholars. In the broad scientific and technical areas defined in the regulations, faculty could not conduct classroom lectures when foreign visitors were present, engage in the exchange of information with foreign visitors, present papers or participate in discussions at symposia and conferences where foreign nationals were present, employ foreign nationals to work in their laboratories or publish research findings in the open literature. Nor could universities, in effect, admit foreign nationals to graduate studies in these areas. Such restrictions would conflict with the fundamental precepts that define the role and nature of the universities . . .

"Restricting the free flow of information among scientists and engineers would alter fundamentally the system that produced the scientific and technological lead that the government is now trying to protect, and leave us with nothing to protect in the very near future. The way to protect that lead is to make sure that the country's best talent is encouraged to work in the relevant areas, not to try to build a wall around past discoveries."

Balancing Act

The unintended transfer of technology to other nations is said to be a serious problem for U.S. national security. University scientists can form no independent judgment of the magnitude of this threat, of course, because the data essential to an informed judgment are, perforce, classified. It is also said that universities contribute to this unintended transfer of technology through their international communities of students, faculty, and research staffs; through the publication of results in the open literature; and through the intrinsic openness of university communities.

Even if this were so, which is far from clear, any potential disadvantage must be measured against the very great advantage to scientific progress, and to the nation, of open and unrestricted research. There is

Continued on page 12

Paul E. Gray is president of M.I.T. This is adapted from an article in IEEE Spectrum, © *May 1982,* IEEE.

also a question of how significant the "leaks" from universities are compared with those stemming from the licensed export of dual-use technologies, the theft or sale of restricted technologies, the operations of multinational companies, disclosure to friendly nations, and so on.

We urgently need a reasoned assessment of this issue so legitimate efforts to restrict the transfer of technology from the universities will be based on proper analysis, a full understanding of how progress in science evolves, and an appreciation of the possible unintended consequences of constraints.

For example, prepublication reviews of sensitive information will not, by themselves, work very well because of the informal communication networks among researchers. Effective control of the dissemination of results would have to be exercised at a much earlier stage. Researchers and visitors would have to pass some sort of reliability test or be excluded from a project. And the informal communications network central to progress in research would have to be abandoned.

Such conditions could be met in a government laboratory or corporate research facility, but they are entirely foreign to universities, where research and education are inextricably entwined, where talent and creativity are sought and developed without regard to national origin, where few doors are locked, and where activities are not sequestered.

The suggestion that universities already have working arrangements with corporations that apply this kind of constraint to privately sponsored research is simply wrong. Though many universities are prepared to accept support from both corporations and government when such support involves brief delays of publication to permit protection of property rights, few universities, I believe, would be prepared to undertake research that is proprietary to a sponsor and that cannot be freely described and reported.

It is to be hoped that the costs and benefits of all possible constraints will be carefully weighed in the national debate over this complex issue. It is encouraging that the Department of Defense and the Association of American Universities have recently established a joint committee to conduct such a review. A similar study is also being undertaken by the National Academy of Sciences. These and other studies could spawn specific recommendations to serve both the cause of national security and the larger progress of science and technology in the broad national interest. □

How many of these Technology Review articles should you have read?

# copies	
☐	"The Japanese Lesson in Quality" by R.E. Cole, July, 1981.
☐	"Solar Cells: Plugging into the Sun," by J.C.C. Fan. August/September, 1978.
☐	"OPEC: Calming a Nervous World Oil Market," by N. Choucri. October, 1980.
☐	"Strategies for Improving Research Utilization," by E.B. Roberts and A.L. Frohman. March/April, 1978.
☐	"System Energy and Future Transportation," by R.A. Rice. February, 1974.
☐	"The Transition to Coal," by R.F. Naill, et al. October/November, 1975.
☐	"Urban Transport We Could Really Use," by M. Wohl. June, 1970.
☐	"What We Know and Don't Know About Inflation," by R.M. Solow. December, 1978/ January, 1979.
☐	"Where have All the Leaders Gone?," by W.G. Bennis. March/April, 1977.
☐	"Telephone Technology and Privacy," by O.G. Selfridge and R.T. Schwartz. May, 1980.
☐	"Variety is the Key to Life," by P.R. Ehrlich. February, 1980.
☐	"Electric Heat: The Right Price at the Right Time," by J.G. Asbury, R.F. Geise, and O. Mueller. December, 1978/January, 1980.

# copies	
☐	"Microprocessors and Productivity," by Robert T. Lund. January, 1981.
☐	"On Avoiding Nuclear Holocaust," by Victor Weisskopf. October, 1980.
☐	"Making Computerized Knowledge Safe for People," by C. Vogt. March, 1970.
☐	"Living With Technology: Trade-Offs in Paradise," by S.C. Florman, August/September, 1981.
☐	"New Patterns of Leadership for Tomorrow's Organizations," by W.G. Bennis. April, 1968.
☐	"New Strategies to Improve Productivity," by A.S. Judson. July/August, 1976.
☐	"The Nuclear Powered Airplane," by F.E. Rom. December, 1969.
☐	"Nuclear Waste Disposal: Not in My Backyard," by A. Jackimo and I.C. Bupp. March/April, 1978.
☐	"Is There A Better Automobile Engine?" by John Heywood and John Wilkes. November/December, 1980.
☐	"Petroleum Resources—How Much Oil and Where?," by R.E. Geiger and J.D. Moody. March/April, 1975.
☐	"The Profit Side of Pollution Control," by T.W. Rothermel. January, 1973.
☐	"Mining Earth's Heat: Hot Dry Rock Geothermal Energy," by R.G. Cummings, et al. February, 1979.
☐	"The UFO Phenomenon: Laugh, Laugh, Study, Study," by J. Allen Hynek. July, 1981.

# copies	
☐	"Sail Power for the World's Cargo Ships," by L. Bergeson. March/April, 1979.
☐	"Analyzing the Daily Risks of Life," by R. Wilson. February, 1979.
☐	"Assessing the Risk of an LNG Terminal," by R.L. Keeney, et al. October, 1978.
☐	"Auto Emissions: Why Regulation Hasn't Worked," by E.S. Mills and L.J. White. March/April, 1978.
☐	"Changing Economic Patterns," by J.W. Forrester, August/September, 1978.
☐	"Computers in Human Society: Good or Ill?," by R.M. Fano. March, 1970.
☐	"Counterintuitive Behavior of Social Systems," by J.W. Forrester. January, 1971.
☐	"The Depletion of Geologic Resources," by E. Cook. June, 1975.
☐	"Electronic Materials of the Future: Predicting the Unpredictable," by R.A. Laudise and K. Nassau. October/November, 1977.
☐	"Energy for Millenium Three," by E. Cook. December, 1972.
☐	"The Future of Computers," by S.E. Madwick. July/August, 1973.
☐	"Debunking the 'Window of Vulnerability': A Comparison of Soviet and American Military Forces," by M.W. Johnson, January, 1982.

You still can!

Yes! Send the reprints I've indicated.
All reprints are $1.50 each.
($2.00 Foreign/Canadian)
Write us for additional discounts on reprint orders over 200 copies.

Total copies _____

Total Amount Enclosed $ _____

☐ Please send list of all available reprints.

Name _____

Company _____

Address _____

_____ **Zip** _____

Return this form to: "Attention: Reprints", Technology Review, M.I.T. Room 10-140, Cambridge, Massachusetts 02139

Engineering for Survival

by Ellen Ruppel Shell

Camouflaged in Jackson Pollock spattered fatigues, soldiers jog to the grunts of their group leader. Men shivering in fur-lined parkas and inch-thick boots huddle around a camp stove, while in an adjoining building, another group sits sweating in shorts and sleeveless T-shirts. Leather-drab executive offices are set off with mannequins clothed in full combat regalia, complete with gas masks.

Madame Toussaud goes to summer camp? No—the United States Army Research and Development Laboratories in Natick, Mass.

Despite appearances to the contrary, this place means serious business. For it's in this smattering of low-slung buildings that much of what makes military life bearable, and even survivable, is conceived. Since 1963, when research centers from five states and Washington, D.C. were combined to form the compact scientific community, Natick researchers have worked to meet the myriad and sometimes unpredictable needs of military men and women. "What they eat, carry, wear, sleep in, and protect themselves with," reads the informational brochure, "are all part of our total commitment."

But you've probably enjoyed the fruits of all this effort even if you've never marched to any but your own drummer. Freeze-dried coffee, "flaked" minute steaks, compressed breakfast bars—these and 20 to 30 percent of all food found on supermarket shelves were based on or developed through military technology. So were Gore-tex water-repellent garments, Kevlar bulletproof vests, and those huge "Mickey Mouse" boots so popular among workers on the Alaska pipeline. Many types of tents and sleeping bags, parkas, gloves, and in fact most of the clothing and shelters sold in outdoor and sporting-goods stores, also have roots in Natick.

And these are mere spinoffs of the laboratory's primary objective—to ensure the survival and relative comfort of over a million enlistees under every conceivable condition and circumstance. "We engineer to extremes," explains John Hansen, director of Natick's individual-protection laboratory. "No single industry could possibly do what we do here." Nor would it want to.

Natick designs and tests food, clothing, and equipment for a very special breed of consumer—what Hansen calls a "captive audience" that can't return goods and shop elsewhere if unhappy with a product. At the same time, the army is painfully aware that inadequate gear—a leaky parka, drafty tent, or malfunctioning parachute—can strike a dangerous, even fatal, blow to an otherwise smooth-running operation. So every item at Natick undergoes tests and scrutiny unheard of in the civilian sector.

U.S. ARMY/NATICK LABS

The best offense may well be a good defense when it comes to modern warfare. The U.S. Army wants to be equipped to withstand just about anything.

The Ultimate Teepee

Take tents, for example. The average civilian tent is hauled out two or three times a year for use on hiking trips in temperate weather. But the army uses tents for something else altogether. The same basic design goes on maneuvers in Norway, the Congo, Alaska, and South America. It must withstand rough handling and misuse, sub-zero temperatures and 70-mile-per-hour winds, jungle rot and drenching downpours. It must seal up completely to hold in light during blackouts, yet be comfortable enough to live in for weeks. And recent international events demand adherence to still another specification: resistance to toxins used in chemical and biological warfare.

To find a portable shelter that will meet these criteria, Natick scientists test hundreds of fabrics rigged in countless configurations. They erect prototypes in a special "rain" room and leave them there for days of horrendous synthetic weather. Finally, the "testing command" hauls them out for field tests in locations all over the world. Ordinary tents might fold up of their own volition under all this abuse, but a recent Natick invention, the Temper, came through with flying colors. These shelters are not only water, fire, mildew, and weather resistant, but they can be complexed into a mammoth unit the size of six or seven conventional models. Inside, these homes-away-from-home are more comfortable than many big-city apartments, with their cloth-covered interior frames, optional wood floors, and fluorescent lighting.

A still more imaginative design, now in the testing stage, is a double-walled, air-supported structure big enough to hold the military's largest helicopter. These 80-foot-long, 2,000-pound miniature hangers can be erected by eight people in less than two hours. They are supported by air beams—hollow shafts that, when pressurized, hold up to the elements as well as steel or wood.

It's one thing to keep soldiers safe and dry within a shelter but quite another to keep them healthy while scrambling around on their stomachs in the muck. Troops spending months in jungle damp, for instance, need water-repellent uniforms.

Quarpel, an extended-resin finish developed by the army 25 years ago, provided an early solution. Surface tension prevents moisture from seeping through intact Quarpel-treated cloth. Indeed, Quarpel-treated trench coats and the like became the basis for a new rainwear industry, quickly replacing suffocating rubberized garments in the general marketplace.

But while Quarpel might be just the thing for a quick dash from car to office, it's simply not good enough for the army. Fabrics stretched over a bent knee or elbow quickly soak through, as soldiers kneeling in rain puddles soon discovered. The key was to find a comfortable, "breathable" material that was inpenetrable to water even when stressed.

When Robert Gore came to Natick a few years back, researchers recognized almost instantly that their waterlog problems were over. Gore had discovered a most unusual property in polytetrafluorethylene (PTFE), a popular polymer more commonly known as Teflon. Stretching the molecule into very thin layers, he found, caused it to form micropores, tiny holes that transmit water vapor but not water itself. When Natick scientists put the stuff between two layers of rip-stop nylon, Gore-tex was born—the

No amount of protection will keep an army marching on an empty stomach.

porous and waterproof material now so popular among the civilian backpacking set.

Barring the Bullet

Of course, bullets and shrapnel often pose a more immediate threat to soldier survival than rainwater. The nylon flak jackets worn by ace pilots in the 1950s are neither comfortable nor entirely effective, but 13 layers of Kevlar are. Kevlar was formulated by DuPont originally for use in automobile tire cord. Unlike nylon and most other fibers, Kevlar doesn't melt when struck by fragments. Instead, it opens into a kind of hair net, spreading the energy over a wide surface and thereby absorbing the impact. Natick scientists found that body armor made of Kevlar provided 30 percent more protection than nylon. Kevlar helmets, designed to meet the contours of the wearer's head, will eventually replace the old "steel pots" so long the brunt of military humor. Lightweight vests made of seven layers of Kevlar are effective against bullets from 90 percent of all "handguns on the street," according to Natick scientists, and are now worn by police, politicians, movie stars, and others in high-risk professions.

But it is not bullets or even conventional bombs that Natick scientists worry most about these days. "Our top priority, our biggest challenge, is to protect our people from chemical, biological, and nuclear threats, in that order," says Hamed El-Bisi, director of Natick's science and advanced-technology lab. El-Bisi explains that "we lost some time in this area" during the Nixon and early Carter administrations because of a moratorium on offensive chemical and biological warfare. "But over the past five years it has become evident to Congress that the chemical threat is real—and we've had to push hard to catch up."

As of now, the only material coming between a soldier and a chemical-laden war zone is a carbon-impregnated urethane foam suit and butyl rubber boots and gloves. This bulky, uncomfortable uniform does the job—activated carbon in the half-

Above: G.I.s wearing these boots appear by their footprints to be barefoot peasants. Right: Kevlar helmets designed to fit the head's contours feel lighter and more stable than traditional headgear. (Photos: © 1982 Walter Bibikow.)

Below: Fireproof suits can withstand incinerating temperatures—but the mannequins can't. (Photo: U.S. Army/ Natick Labs) Below left: Soldiers test clothing under extreme conditions in the "weather room." (Photo: © 1982 Walter Bibikow)

Above right: Inflatable tents erected in a couple of hours by an eight-person crew can shelter the army's biggest helicopter from the harshest weather conditions. (Photos: U.S. Army/Natick Labs)

"No single industry could possibly do what we do here."

inch foam matrix absorbs the gases. The military demonstrated its interest by ordering $200 million worth of the suits. But carbon is quickly rendered inactive by the acids in human sweat. Hence the uniforms lose their effectiveness after just two or three weeks of wear. No wonder, then, that Natick researchers have focused their efforts on finding an alternative.

One possibility is to cover the suits with a nonwoven material such as Gore-tex that would allow perspiration to escape before it could contaminate the carbon. Another entails putting the carbon into hollow polypropylene—fibers that have water-permeable but not chemical-permeable sheaths. This would reduce the problem by making the suits a good deal lighter and cooler.

But probably the most innovative method avoids using carbon altogether. Instead, it entails treating cloth with enzymes that degrade chemical toxins on contact. Specific enzymes could be manufactured by microorganisms tailored through recombinant-DNA techniques. However, the problem is complicated because toxins rarely consist of a single chemical. "The chemical mix requires some kind of generic solution," lab director Hansen explains, one that, like carbon, would be effective against an alphabet soup of toxins.

Meanwhile, Natick researchers are working on a parallel pitfall of chemical-protection wear—flammability. Flameproof fabrics made with Nomex, a distant cousin of nylon and another DuPont product, have long been used in military flight suits. But Nomex cannot protect its wearers from extended exposure to high temperatures. Using mannequins rigged with thermocouples, Natick scientists learned that even when fortified with Kevlar for strength, Nomex suits can keep people alive for only four seconds in a 2,000-degree environment—the kind of inferno found, for instance, in the pilot seat of an exploding helicopter. Nomex kept the dummies from burning, alright, but did not prevent them from cooking in their flameproof suits—like turkey in a broiler bag.

Hansen predicts that the next generation of flame-resistant fabrics will overcome this drawback with the help of intumescent substances: molecules that chemically change with heat, thereby using up the thermal energy that would otherwise burn or boil the wearer. There is excellent precedent for the use of these materials: the nose cones of spacecraft treated with intumescent chemicals survive the incinerating effect of atmospheric friction. Though still in the experimental stage, fibers filled with intumescents should prove as effective.

While still no gourmet treat, today's military rations are more convenient and palatable than "C" rations.

Despite the promise of these and other techniques, however, Natick administrators confess that they haven't quite "caught up" in the race toward total protection from chemical threats. In fact, they wax downright pessimistic when estimating the probability of survival of soldiers caught outside a vehicle in future battle zones. However, this has less to do with poison than it does with a more fundamental military nemesis—heat.

"My feeling about protecting the dismounted soldier during chemical warfare in the desert is pretty simple," says Hansen. "You can't get there from here." Existing chemical protection suits are so hot and bulky that they would kill or incapacitate more desert fighters than they would protect. But tank-bound forces could manage in relative comfort, thanks to a liquid-cooled vest pumped with a refrigerated mixture of ethylene glycol (antifreeze) and water. "Ground vehicles absorb solar heat and become radiators," Hansen says. "And helicopters are like greenhouses—they get hotter than you can imagine. It's impractical to air-condition these vehicles, but we can create a microclimate for the people inside them."

Tests show that these lightweight "liquid conditioning systems" keep tank-bound crews cool in temperatures upward of 100°F. Without such vests, body temperatures rise to dangerous levels after just 80 minutes.

Goodbye to K.P.

Of course, no amount of protection will keep an army marching on an empty stomach. Natick takes this adage so seriously that it devotes two laboratories and an operations-research group almost entirely to the development of edibles.

Not surprisingly, the standard fare for the modern GI on the move is an "assault pack." These plastic-covered trays contain everything from chicken to Chiclets, yet are lightweight and low in volume. The weight and bulk of some assault-pack items (which require little or no cooking) are reduced by 90 percent through freeze-drying and compression. Processors freeze the food and then sublime off the water in a vacuum. The product is then slightly moisturized to make it pliable, compressed, and dried again. This technique preserves flavor and texture but is so expensive that it has received limited use in both military and civilian sectors. However, since the amount of food soldiers or military conveyances can carry often determines the length of time they are fit for battle, reducing the cost of the freeze-dry/compression process has become a "primary technical challenge," according to Abner Salant, director of the Natick food engineering lab.

Military personnel with access to camp kitchens may soon owe their next heartburn to still another Natick innovation, the Tray-Pack. These large, flat, tin-plated steel containers will substantially reduce labor and energy costs, Salant says, though it is unlikely they will help the army win a three-star rating from Michelin.

The key to the Tray-Pack's apparent success is its geometry. Ordinary cylindrical cans require extensive heating to insure that all the food within them is cooked. This sometimes results in the overcooking

of at least part of the can's contents, as anyone who has eaten a tin of soggy corned beef or peas will attest. The low, flat Tray-Pack requires less heat for processing, thus conserving energy as well as preserving the flavor and texture of foods. It can also contain such previously impossible-to-can concoctions as lasagna. But it is bottom-line, not gastronomical, considerations that make this invention so attractive. Natick's operations-research experts have determined that implementation of the Tray-Pack system could save the military $200 million a year in personnel costs alone—by all but eliminating kitchen duty and reducing the need for trained cooks.

Tight money is also the motivator for still another Natick research effort: meat restructuring. Cheap cuts normally used for hamburger, stew, or worse are shaved into flakes, frozen, tempered, and shaped into steak and cutlet facsimilies that have been known to satisfy even picky civilian palates. With sirlon selling for almost $4 a pound, it's no wonder that there is a lively interest in restructured products among commercial meat processors.

A more adventurous approach to reducing the military's $700 million annual meat bill may well earn even broader acceptance than restructuring, once approved by the Food and Drug administration. Also developed at Natick, this method is essentially a speeded-up version of classic meat aging. Beef becomes tender when aged because natural tenderizing enzymes, called cathepsins, are released from the animal's spleen. Unlike commercial tenderizers extracted from plants, cathepsins work directly on tough connective tissue, leaving the muscle and essential texture intact. Hamed El-Bisi predicts that the use of these enzymes will cut military meat costs in half.

The list of Natick brainchildren goes on and on. Tents and uniforms camouflaged to elude infrared detectors have recently become standard issue. Chicken feathers transformed with Natick ingenuity approximate the insulating capacity of goose down. Food irradiation, a process conceived and developed at Natick, has been adopted by many less-developed countries as a potent weapon against food and seed spoilage. In fact, it's difficult to isolate a human need that hasn't received at least some attention in this small suburban outpost. "But if you think of any," director Hansen chuckles," let us know." □

Ellen Ruppel Shell is a senior editor of Technology Review.

Meeting Japan's Challenge

Tenth in a Series

GIVE AMERICAN WORKERS THE RIGHT TOOLS AND THEY CAN OUTPERFORM ANYBODY IN THE WORLD.

At Motorola, that's a long-held belief. More than that, it's a long-term business principle.

We've been operating on this principle for at least fifteen years. And we've coined a name for it. We call it Tool Management Culture (TMC).

TMC means supplying every employee with the best equipment to do the job. From pencils to computers. TMC also means investing the resources to make it work. And invest we do. Of 1981's capital expenditures of $317 million, nearly 70% was put behind TMC.

But it also takes employee understanding and motivation to make TMC work. Because employees are the prime movers in recommending new tools, methods and techniques.

That's where our Participative Management Program has been a tremendous help. Because this program not only makes every employee a member of the management team, it allows them to make recommendations to improve their own productivity.

Motorola's R2001. In one "in-the-field" test unit: a signal generator, a frequency, modulation, and RF power meter, a spectrum analyzer, a duplex generator, RF memory tables, a code synthesizer, an audio frequency counter, a digital voltmeter, an oscilloscope, and a sweep generator.

As participants in management, Motorola people know that better tools produce better quality, higher productivity, increased demand in the marketplace. And that helps reduce costs, preserve jobs, and make the company's products more competitive.

Take our Communications Sector for example. With thousands of people in the field servicing land mobile communications products with dozens of separate pieces of test equipment, our people saw a need for something better. So they invented the R2001, a single in-the-field test unit that could handle 12 functions in one test unit.

There isn't another piece of service equipment like it. Amazingly, it not only services all Motorola's land mobile communications products, it can service anyone else's. As a result, the R2001 has expanded the test equipment market for us, in addition to providing a better tool for our own people.

Clearly, it's for reasons like this we're a world leader in land mobile communications. And it's also an example that proves our point.

Giving people the right tools can help a company work a lot smarter.

But to give them the right tools, you've also got to give them their heads.

And once you do that, they'll help you compete with anybody at home or abroad.

MOTOROLA A World Leader in Electronics.

Quality and productivity through employee participation in management.

Literacy/Continued from page 6

grew stronger—more students, more grants—he found that he was being treated with increased respect within the institution's adminsitrative councils. His audience applauded, and I did, too—but not lustily.

I suppose one thing that bothers me about the current trend is the attitude of students as reflected in polls. A recent survey, by the University of California at Los Angeles and the American Council on Education, shows that the proportion of freshmen who see being very well off financially as a very important goal has grown from 49 percent in 1969 to 65 percent in 1981. At the same time, those who highly value the goal of "developing a meaningful philosophy of life" has declined from 83 to 49 percent. Also, goals such as "helping others in difficulty" have been declining in importance. I do not say that the increased popularity of engineering is causally related to these developments. But I do feel that, given the existing situation, we should be extremely cautious about further wounding the liberal arts, particularly the humanities.

The Sloan people, to be sure, have no such objective, as their letter of invitation makes clear: "The Foundation does not seek and would not welcome any reduction in the commitment of liberal-arts colleges to the humanities and the social sciences." But how are new programs to be introduced *except* at the expense of existing ones?

At a recent conference at Lehigh University on "The Fundamentals of Engineering in a Liberal Education," participants suggested that courses be developed for liberal-arts students in such areas as decision analysis, systems engineering, and modeling theory. The prospect of such courses displacing medieval history, Elizabethan poetry, and the Russian novel gives me the chills. Our new tools of analytical reasoning are powerful to be sure. But they lead to simplistic theories, particularly in economics and political science, that are constantly being shattered on the reefs of human perversity—the very stuff one learns about by reading history and literature.

Rounding Out the Regimen

If simple technological literacy is the objective—for example, knowing how to use a computer, as every high-school graduate will one of these days—then this goal could conceivably be pursued outside the academic curriculum. When I entered college, physical education was compulsory, and because I arrived during World War II, our class was required to pass a stiff physical-fitness test. I was unable to climb a rope, so I was required to follow a regimen that included working out on the parallel bars and running three miles a day. This did me a world of good, and I would like to see an enormous grant provided to the first liberal-arts college that proposes a similar solution to the problem of technological illiteracy. Come to think of it, engineering schools could attack humanistic illiteracy (a much more serious disease) by requiring their students to pursue not-for-credit regimens in reading and attending cultural events.

The flow of human affairs is carrying technology to new heights, and it is certainly not the Sloan Foundation's mandate or intention to oppose this flow or even to divert it. I would feel better if I thought that the technology that is threatening to "take over" were at least of an enriched variety. The fact that engineering students have continued to ignore opportunities to explore the liberal arts while liberal-arts students have at least curiosity about technology does not speak well for the impending conquerors, nor augur well for the new age we appear to be entering. As an engineer I wish I felt better about the rise in fortune of my own profession. □

Samuel C. Florman, an engineer, is vice-president of Kreisler Borg Florman Construction Co. in Scarsdale, N.Y. He is author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, *and* Blaming Technology.

Letters/Continued from page 2

Compared mathematically to smoking and driving, almost everything seems relatively risk-free and hence almost nothing seems worth regulating. I think that I understand Mr. Ritter's bill, and I just don't like it.

Of course, I endorse bringing analysis to bear on questions of risk, and I trust that the talented and resilient Mr. Ritter will find more constructive ways to furthering this objective.

Coal-Ship Facts

There are a few errors in "A Coal Steamer for the 1990s" (*February/March, page 78*). Happily, the shipyard cost of a coal ship is not going to be $600 million but only $60 million. The England Electric System also decided to have two boilers on the ship instead of one for security of operation. Both boilers, of course, can burn either coal or oil. The oil-carrying capacity of the ship will be about 5,000 barrels (not gallons) of bunker fuel oil.

In the first few years of operation, we expect the combined cost of fuel and coal-burning equipment to be somewhat higher than the operating cost of an oil-fired propulsion system. However, this does not mean that the ship will operate at a net loss.

James A. Monk, Jr.
Westborough, Mass.

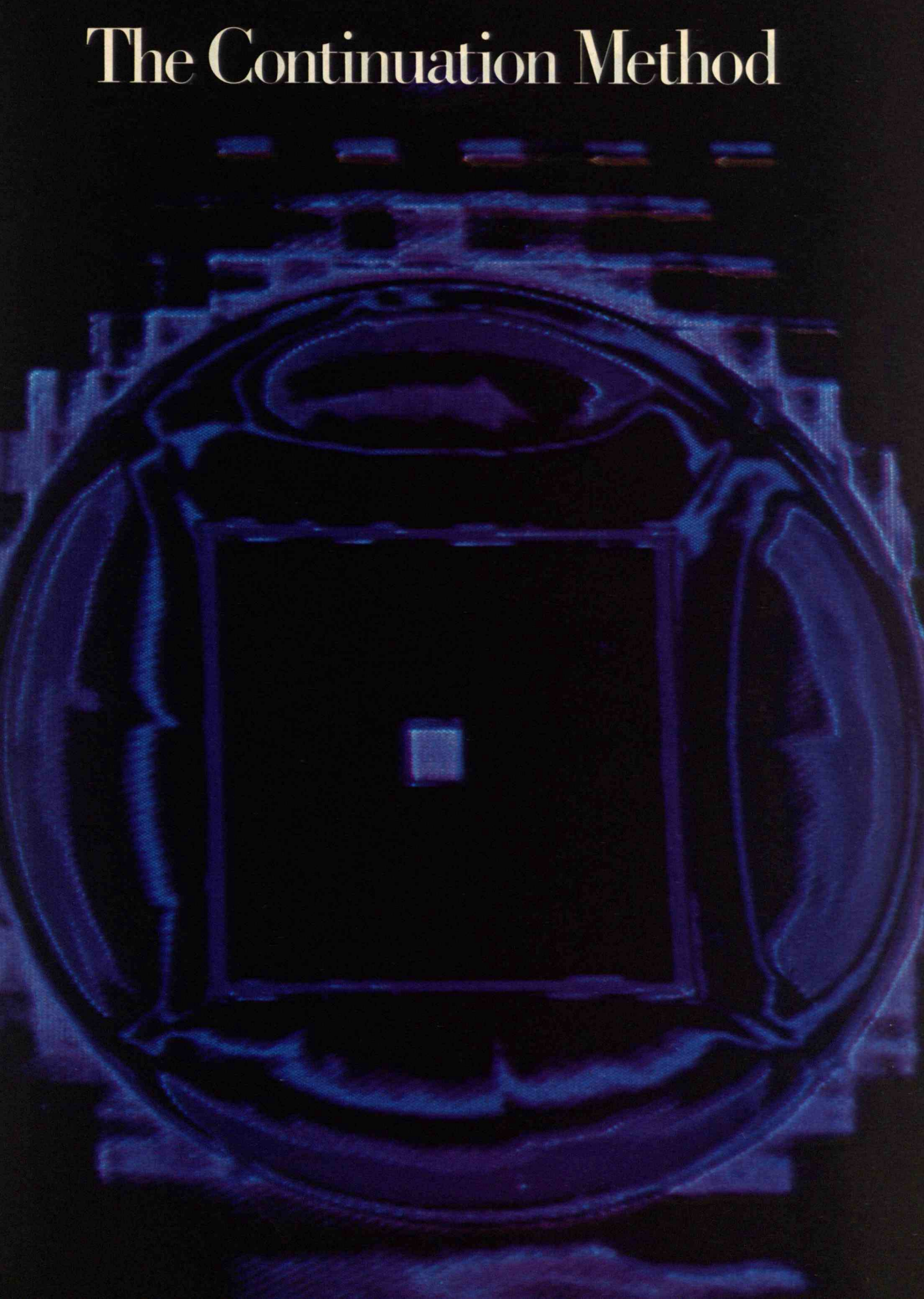
Skewed History Too Simple?

Lest it be thought that R.T. Jones has a complete monopoly on the development of "skewed-wing" technology (*see "Trends," April, page 78*), let me add to the record: M.I.T. undergraduates in the "Aeronautical Systems" course under my supervision considered the preliminary design of a skewed-wing business airplane in the spring of 1978. Previous NASA work on the concept had centered on a 2,090-passenger aircraft that the airline industry is unlikely to fund, and Mr. Jones himself commented to us on the appropriateness of a business-airplane application.

E. Eugene Larrabee
Cambridge, Mass.

The writer is associate professor of aeronautics and astronautics at M.I.T.—Ed.

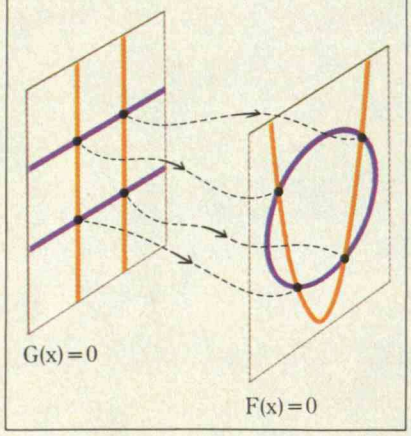
The Continuation Method



The Continuation Method

The need to solve systems of polynomial equations arises in pursuits ranging from geometric optics to chemical kinetics. A practical method of solution, developed at the General Motors Research Laboratories, provides designers of mechanical parts with a new capability.

Two equations in two unknowns



The two pairs of parallel lines of G(x) = 0 evolve into the parabola and ellipse of F(x) = 0.

The three pairs of parallel planes of G(x) = 0 evolve into the paraboloid, ellipsoid and cylinder of F(x) = 0.

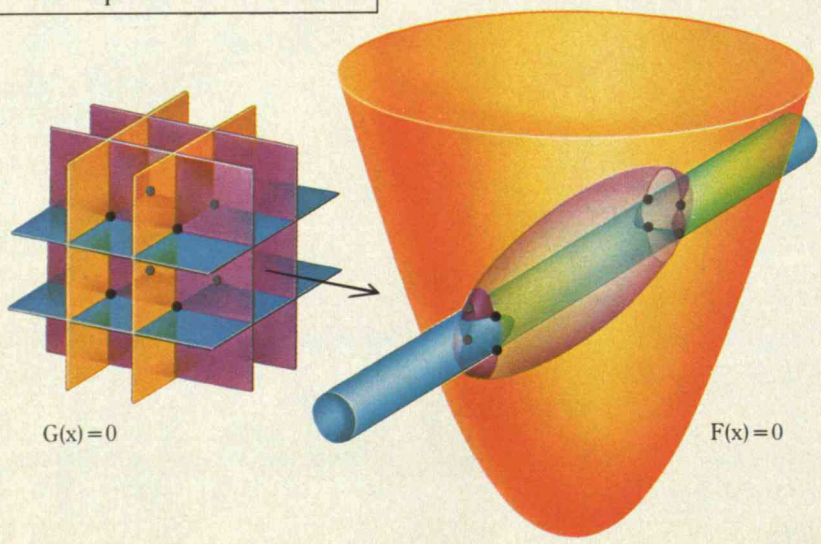
CLASSICALLY difficult non-linear equations—those made up of polynomial expressions—can now be solved with reliability and speed. Recent advances in the mathematics of continuation methods at the General Motors Research Laboratories have practical implications for a wide range of scientific and engineering problems. The immediate application at General Motors is in mechanical design. The new method finds all eight solutions to three quadric equations in a few tenths of a second—fast enough for computer-aided design on a moment-to-moment basis. Algorithms based on this method are critical to the functioning of GMSOLID, an interactive design system which models the geometric characteristics of automotive parts.

Systems of non-linear equations have been solved for many years by "hit or miss" *local* methods. The method developed at General Motors by Dr. Alexander Morgan is distinguished by being *global* and *exhaustive*. Local methods depend on an initial estimate of the solution. They proceed by iterative modifications of this estimate to converge to a solution. However, success is not guaranteed, because there are generally no practical guidelines for making an initial choice that will ensure convergence. Reliability is further compromised when multiple solutions are sought.

Global methods, by contrast, do not require an initial estimate of the solution. The continuation method, as developed by Dr. Morgan, is not only global, but also exhaustive in that, assuming exact arithmetic, it guarantees convergence to all solutions. The convergence proof rests on principles from the area of mathematics called differential topology.

Here is the way continuation works. Suppose we want to solve a system $F(x) = 0$. We begin by generating a simpler system $G(x) = 0$ which we can both solve and continuously evolve into $F(x) = 0$. It is important that we select a G properly, so the process will converge. Dr. Morgan has devised a method for selecting G which gives rapid convergence and reliable computational behavior. He first applied a theorem established by Garcia and

Three equations in three unknowns



Zangwill to select G. However, the resulting algorithm could not achieve the speed and computational reliability necessary for several applications. Next, he utilized some ideas from algebraic geometry—"homogenous coordinates" and "complex projective space"—to prove a new theorem for selecting G. The result of Dr. Morgan's efforts is a practical numerical method based on solid mathematical principles with innate reliability.

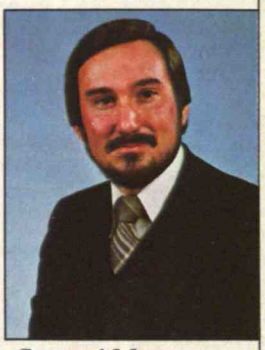
Reliability is the critical element for mathematical methods embedded in large computer programs, because errors may not become evident until after they have ruined a large data structure compiled at great expense and effort. Speed is also important to economical real-time implementation. This method has proved to be reliable and fast in solving problems involving equations up to the sixth degree in three or four variables. However, there are obvious practical limitations on the number of equations and their degree, due to the limited precision of computer arithmetic and computer resource availability.

THE FIGURES illustrate the transition from simple $G(x)=0$ to final $F(x)=0$. In both figures, the "simplicity" of $G(x)=0$ is reflected graphically in its linear structure—seen as lines and planes. The non-linearity of $F(x)=0$ is seen in the curvature of the final shapes in each figure.

In figure 1, the four dots on the left plane represent the set of simultaneous solutions to the system of equations $G(x)=0$. The four dots on the right plane represent the set of simultaneous solutions to the system of equations $F(x)=0$. The dashed lines represent simultaneous solutions to intermediate systems whose graphs would show the evolution from one configuration to the other. With the addition of a third dimension in figure 2, the number of dots representing simultaneous solutions doubles. Representation of the transitional points, as in figure 1, would require a fourth dimension.

"Continuation methods, although well known to mathematicians," says Dr. Morgan, "are not widely used in science and engineering. Acoustics, kinematics and non-linear circuit design are just a few fields that could benefit immediately. I expect to see much greater use of this mathematical tool in the future."

THE MAN BEHIND THE WORK



Dr. Alexander Morgan is a Senior Research Scientist in the Mathematics Department at the General Motors Research Laboratories.

Dr. Morgan received his graduate degrees from Yale University in the field of differential topology. His Ph.D. thesis concerned the geometry of differential manifolds. Prior to joining General Motors in 1978, he taught mathematics at the University of Miami in Florida and worked as an analyst at the Department of Energy's Savannah River Plant in South Carolina.

While serving in the U.S. Army, Dr. Morgan participated in the development and analysis of simulation models at the Strategy and Tactics Analysis Group in Bethesda, Maryland.

Dr. Morgan's current research interests include the qualitative theory of ordinary differential equations and the numerical solution of non-linear equations.


EUROPE
ICELAND
BRITISH ISLES
SPAIN

Winning Through Sophistication: How to Meet the Soviet Military Challenge

by William J. Perry and Cynthia A. Roberts

The United States must compete not with numbers of weapons but with selective use of its advanced technology.

For over a decade, the Soviet Union has been outproducing the United States by more than two to one in almost all categories of conventional weapons—tanks, aircraft, missiles, and ships. Given their high priority on military production and development, together with their growing technological sophistication, the Soviets have not only been able to overwhelm the United States in numbers of weapons, but to compete in performance as well. Indeed, impressive advances—from the MIG-27 to the Typhoon submarine—typify the high-performance systems now entering the Soviet armed forces.

The Soviets have achieved this numerical advantage not by building simple, cheap equipment as is popularly supposed; they lead the United States because they spend twice as much on military equipment. The large increases in defense spending proposed by the Reagan administration will not by themselves redress this disparity, because Moscow's larger outlays for military equipment do not depend on a larger Soviet defense budget but on allocations within the defense budget.

The Soviets have an advantage because they allocate less than one-fourth of their military budget to labor costs. By comparison, more than half the U.S. defense budget goes to salaries for the volunteer force, retirement pay, and related labor costs. As a result, even with equal defense budgets, Moscow can afford to spend twice as much on weapons procurement. During the 1970s, the Soviets spent $350 billion (1982 dollars) more than the U.S. on military equipment, R&D, and facilities, even though the overall defense budgets were about equal during the first half of the decade.

Thus, the Soviets do not have to trade off quantity for quality; they are able to pursue both. There is no simple way for the United States to respond to this challenge. As a relatively affluent society with attendant high labor costs, the U.S. is essentially caught in a vise: it cannot simply double the quantity of weapons it produces, even at the expense of quality, because larger quantities of equipment require increases in labor that only aggravate the basic cost problem.

Nor can the United States any longer assume that the quality of its weapons systems will ensure the needed performance edge. Ten years ago, American fighter airplanes were so superior to their Soviet counterparts that the United States could compete successfully despite a two-to-one numerical disadvantage. But present Soviet tactical aircraft are characterized by improved maneuverability, extended range, and upgraded avionics. The U.S. cannot compete with

this performance level simply by increasing the complexity of its airplanes. American aircraft are already designed near the "knee of the curve," and further performance improvements will require significant increases in cost and complexity.

Rather than attempt to compete with the Soviets by matching them weapon for weapon, the United States must exploit its particular strengths to the fullest by using its technological lead to "finesse" Soviet numerical superiority. This "offset strategy" should be based on the selective application of technology where it leads to high-leverage increases in military effectiveness. Such a strategy is not rooted in a naive faith in the magic power of technology, nor does it overlook the importance of reducing key numerical disparities.

Of course, the United States is not alone in confronting the Soviet challenge—it has allies whose aggregate industrial strength is equivalent to its own. But the alliance must be truly coherent for this potential advantage to be realized. In particular, the United States must make available to its allies the same technological advantages incorporated in its own weapons. This will require a much higher degree of cooperation than has been evident to date.

Systemic Differences

To understand how best to apply the U.S. technological advantages, we must first appreciate the basic differences between the U.S. and Soviet processes of acquiring weapons. First, according to CIA estimates, the Soviet Union spends about twice as much on defense research and development as the United States. Second, the Soviet educational system graduates many more engineers than the United States. In 1980 alone, the Soviet Union conferred degrees on 300,000 engineers, while the U.S. figure was roughly 60,000. Third, the Soviet Union is intensely developing approximately twice as many different weapons systems as the United States. And finally, the Soviet system of design bureaus provides a continuity to weapons development that has almost no parallel in the United States. Not only do chief designers and industrial ministers tend to have long tenure, but the number of workers and the level of activity at major Soviet R&D installations grow at a relatively constant rate. In contrast, only rarely does an American defense contractor work on one program for 20 or more years.

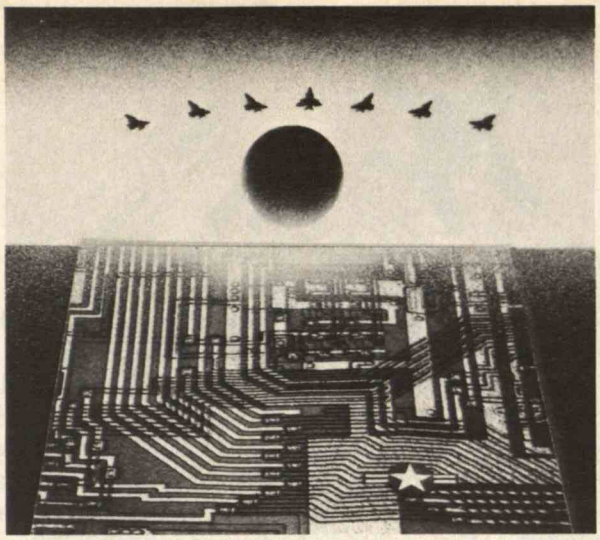
While these differences are real enough, taken by themselves they can be misleading. Although the Soviet Union does invest twice as much as the United States in defense technology, this military effort is the country's major area of research and development. In the United States, Europe, and Japan, on the other hand, there is a vast technological infrastructure not funded by defense but exploited by it. No real counterpart to this commercial high-technology sector exists in the Soviet Union.

The field of microelectronics is probably the best example of this difference. The U.S. semiconductor industry derives less than 10 percent of its sales from the Defense Department. Thus, nearly all of that industry's R&D is supported by profits from commercial sales. Yet the West has the greatest advantage in defense systems involving microelectronics components and the computers derived from semiconductors. The microprocessor, which plays a key role in the new generation of precision-guided munitions, was essentially a commercial development. This area of significant American advantage is not apparent from a comparison of U.S. and Soviet defense expenditures.

That the Soviets have been able to narrow the American lead in certain key technologies, including navigation, optics, and propulsion, is indicative of the intensity of Soviet efforts and a powerful reminder that the U.S. cannot take its technological advantage for granted. Indeed, the successful application of the offset strategy depends on significant real growth in defense R&D as well as an improvement in the U.S. ability to make timely applications of commercial technology to its weapons systems.

A "body count" of U.S. versus Soviet engineers is also misleading because it is not indicative of the relative ability to create new technology. Soviet engineers are neither trained nor encouraged to be innovative, and many are placed in jobs filled in the United States by technicians. American engineers, on the other hand, are substantially more creative, and this creativity is clearly reflected in the enormous U.S. lead in technical innovations. It is no accident that the Soviets themselves worry about the inefficient use of their many engineers as well as their general lack of creativity. Some Soviet analysts have even urged that changes be made in the education of Soviet engineers.

The fact that the Soviet Union is building more weapons systems than the United States is also a mixed blessing for Soviet leaders. Large-scale series production of related systems, such as tanks and mis-



The West has the greatest advantage in defense systems involving microelectronics components.

siles, reduces uncertainty and may lead to decreased unit costs. It has also led to a corresponding Soviet advantage in the age of weapons in the field. The Soviets often field one and one-half to two generations of equipment while the West fields one generation. But building such enormous quantities of military equipment can also result in waste and inefficiency. The Soviet military procurement system apparently does not include a way to cancel programs once they are started.

For example, the Soviets have developed at least 11 different intercontinental ballistic missiles (22 counting modifications). All were produced and deployed, except for two, the SS-10 and SS-16, which appear to have been technical failures. Such redundancy in design and production is bound to absorb defense resources—both rubles and engineers—without yielding corresponding benefits.

Finally, the fact that Soviet design bureaus and factories maintain not only a large effort but also continuity *is* reason for concern. For example, sustained high rates of Soviet tank production permit evolutionary improvements in design and technology. Moreover, during the last few years Soviet military production facilities have been constructed at the highest level of the past two decades. Yet the USSR's 135 major assembly plants and over 3,500 individual factories do not compensate for Soviet barriers to successful innovation, which are rooted in the centralized system of planning and supply and administrative control of prices and bonus incentives. Indeed, the failure of certain high-technology industries (such as computers) to keep pace with technical developments in the West has continually restricted Soviet military options.

The development of the cruise missile clearly reflects the shortcomings of the Soviet approach. Because the Soviet air-launched cruise missile is an evolutionary modification of jet aircraft, it is very heavy, has a short range, and is relatively inaccurate. In contrast, the American system of competition among contractors paved the way for development of a strategic cruise missile that is a fivefold improvement over the Soviet version in range, weight, and accuracy. It will probably be at least five years until a comparable cruise missile becomes operational in the Soviet Union.

Thus, the nature of each weapons system is a determining factor in the ability of the Soviet Union to compete with the U.S. in system performance. Notably, the Soviets excel in the development of military systems where improvements in effectiveness can be achieved through progressive modifications. And their true metier is an ability to create innovative designs for weapons constructed with off-the-shelf components, as evidenced by the ZSU-23/4 antiaircraft gun and the BMP armored personnel carrier. But the Soviet record for technological innovation, such as those required by the cruise missile program, is less impressive.

The bottom line is that the United States leads the Soviet Union by approximately five or more years in the technologies of greatest significance to defense. Although the Soviets have closed or are closing the gap in some areas, this is not the case for the most important technologies such as microelectronics. As a result, the United States has the opportunity to use technology to offset the Soviet effort. Equally important, the United States can exploit technology to produce defense equipment that is easier to operate and maintain and less expensive to procure.

Tanks versus Smart Weapons

East-West competition in armored forces shows how technology can be used to offset a numerical disadvantage. The Soviet Union currently fields more than 40,000 battle tanks, compared with just over 10,000 for the United States. Moreover, the balance in tank inventories will deteriorate further when the Soviet Union produces its newest tank, the T-80, at a probable rate of 2,000 units per year, or twice the number of tanks the United States hopes to produce during the same period.

The offset strategy does not call for the United States to procure 30,000 additional tanks or try to create a tank many times more effective than the Soviet tank. According to Lanchester in his famous treatise on military combat, there is a square-law relationship between quality and quantity. Thus, American tanks would have to be sixteen times as effective as Soviet tanks to offset a four-to-one Soviet quantitative advantage. Considering that Soviet tanks are already quite impressive, this is not a realistic option. Even if the United States proceeds with planned production of the M-1 tank, as we believe it should, America will still be outnumbered by four to one in tank forces. The alternative is to deploy the most effective and cost-efficient mix of armor and antiarmor weapons in numbers sufficient to meet the numerically superior threat.

Critical to this approach is the U.S. deployment of antitank guided missiles that exploit the technology of precision-guided munitions (PGMs). Popularly referred to as "smart" bombs, PGMs are conventional munitions that can be precisely guided to the target after being launched. Such weapons literally "zero in" on either fixed or moving targets such as tanks.

The vast array of antiarmor weapons under advanced development today has come a long way from the unreliable devices used in World War II. Major advances in smart weapons now permit accuracies that approach a "one-shot, one-kill" capability. Moreover, contemporary precision-guided munitions may be deployed in a variety of ways. They can be fired from airplanes and helicopters or by individual soldiers—they are the portable modern bazooka. Precision guidance can also be incorporated in artillery projectiles, so that a 155-millimeter artillery round can make a direct hit on a moving tank at a range of 10 miles. By coupling the large quantity of U.S. self-propelled artillery with the so-called cannon-launched guided projectile—the Copperhead—designers can convert an antipersonnel weapon into a very effective antitank weapon.

To ensure that this offset strategy is viable, the United States must maintain a vigorous effort on all three generations of precision-guided munitions. First-generation PGMs developed in the mid-1960s are now in service. However, these accurate, relatively inexpensive weapons have two major drawbacks: their accuracy is affected by weather conditions, and the operator is vulnerable to counterfire. For example, after firing the TOW (tube-launched, optically tracked, wire-guided) missile, a gunner still has to keep the cross hairs of the sight on the target. Electrical signals transmitted through the wire automatically correct any deviation between the sight path and the track of the missile.

Second-generation laser-guided PGMs, such as the Copperhead and the Hellfire, were developed during the 1970s and are now entering NATO inventories. Although these antitank weapons are much more lethal and easier to operate, they are still weather dependent, and their operators are vulnerable. Yet first-generation and second-generation PGMs will be the mainstay of NATO forces through the 1980s. As of 1980, Warsaw Pact countries had twice the number of antitank missiles in Central Europe as NATO, so deployment of these weapons should continue until third-generation systems are well into production.

In contrast to the precision-guided munitions now deployed, third-generation PGMs will be "fire and forget," greatly reducing operator vulnerability and weather limitations and giving NATO forces a competitive edge in ground combat. The technologies now under development for this generation include millimeter-wave radar and infrared sensors configured in "focal-plane arrays." These are clusters of approximately 1,000 individual sensors, each on a tiny chip. The resolution of these sensors is sharp enough to distinguish a vehicle the size of a tank from one much smaller or larger, thus permitting selective targeting. These technologies will allow third-generation PGMs to operate effectively in adverse weather conditions and with less susceptibility to enemy fire and other countermeasures.

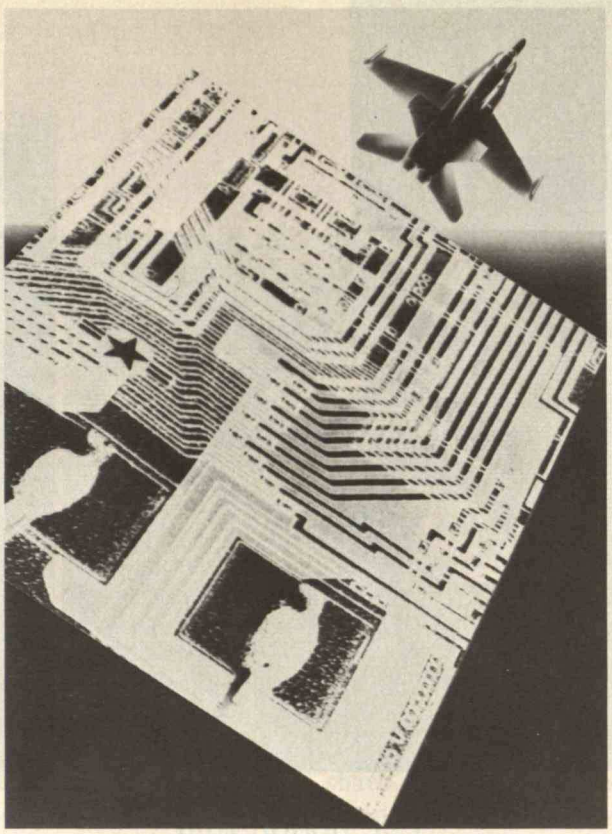
Significant advances in the field of miniaturization in the past four years have not only made these weapons more efficient but have also opened up completely new possibilities. Sophisticated sensors and computers that a decade ago would have filled a large room are now small and rugged enough to fit into an artillery shell such as the Copperhead. Another example is the U.S. Tank Breaker, a portable weapon being developed with focal-plane arrays and infrared guidance that will allow a soldier to engage a main battle tank.

Still more ambitious is the Assault Breaker, a long-range system designed to interdict rear-echelon enemy armor. Each warhead contains 30 to 40 submunitions guided independently to multiple targets. Thus, one such Assault Breaker could engage a whole company of tanks. These technological developments will provide true "fire and forget" capability and make an enormous difference in overcoming the vast numer-

ical inferiority of U.S. tank forces.

Stealth and Electronic Countermeasures

Another technology that can neutralize the Soviet threat lies in the U.S. ability to penetrate Soviet air defenses. The Soviets' lead in air defense is even greater than their advantage in tanks. Whereas the United States maintains no continental surface-to-air missiles, the Soviet Union has deployed more than 10,000 surface-to-air missiles for strategic air defense alone. (This figure does not include surface-to-air missiles deployed with Soviet combat forces.) Overall, the Soviet Union has invested more than $100 billion in strategic air defense.



The United States can exploit technology to produce defense equipment that is easier to operate and maintain and less expensive to procure.

The most practical U.S. approach for dealing with this discrepancy is not to invest $100 billion in air defense but to develop ways of defeating Soviet air defenses. Two technologies, stealth (or "low observables") and electronic countermeasures, together constitute a formidable response.

An airplane is considered "low observable" if its characteristics detectable by radar can be reduced tenfold. For example, reducing the cross-section of a fighter bomber, as it appears to a radar operator, from ten square meters to one square meter decreases the range within which an opposing air-defense system can operate by about a factor of two. Consequently, the air-defense system has only half as much time to engage the low-flying, fast-moving airplane, making the job more difficult. And *very* low observable aircraft are virtually impossible to detect and intercept.

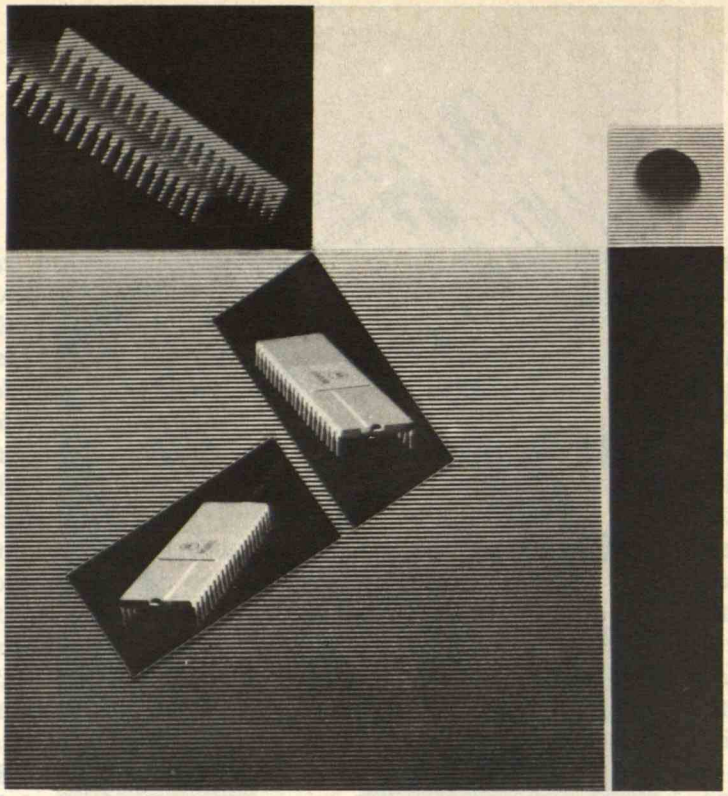
Although public discussion of stealth technology has focused on the strategic bomber, "low-observables" technology will be incorporated to some extent in all future military airplanes and missile systems. The first stealth vehicle, the air-launched cruise missile (ALCM), will become operational this year. The radar cross-section of the ALCM is one-thousandth that of the B-52 strategic bomber, and thus can defeat existing Soviet air defenses. The next generation of stealth programs will apply this technology to tactical airplanes, strategic bombers, and the ALCM follow-on.

A special synergism is created by combining stealth and electronic countermeasures (ECM) such as radar jamming, which reduces the ability of an air-defense system to track its target. For example, if the cross-section of a military aircraft is reduced by a factor of 100, the power required to jam enemy radar may be reduced by the same factor. An ECM system requiring large, complex, high-power tubes, for instance, may be replaced with a system that is entirely solid state. Stealth therefore gives an airplane the same level of ECM effectiveness while reducing the complexity, cost, and weight of the ECM components as well as increasing reliability.

That stealth makes the task of radar jamming less demanding does not mean that the United States should allow its state-of-the-art ECM capability to lag. Advancing ECM technology is imperative to cope with the rapidly expanding threat from new Soviet fighters, long-range interceptors equipped with a "look-down, shoot-down" capability, airborne warning and control systems, and missiles using monopulse radars, which pose particularly difficult problems for an ECM system.

Avoiding Dogfights

The third category of weapons development, tactical aircraft, is the most controversial and misunderstood example of technology's contribution to U.S. defense preparedness. Proponents of the "simpler-but-more" school argue, as James Fallows did in his recent book



The notion that the use of microelectronics increases the cost of equipment has no basis in reality. Complexity, not technology, is the culprit.

National Defense, that the United States should abandon its costly pursuit of technological perfectionism and instead build large quantities of simpler and less expensive airplanes.

Advocates of the "superior-quality" approach, on the other hand, emphasize that by capitalizing on its technological superiority, the United States can continue developing and deploying sophisticated aircraft and avionics systems superior to those of the Soviet Union. But extreme proponents of this school generally underestimate the importance of numbers of weapons. And by succumbing to the "technological imperative," these analysts are often reluctant to advocate procurement of systems that fall short of perfection, thus slowing deployment even further. Framing the debate in "quantity-versus-quality" terms is therefore misleading.

The crux of the problem turns on the steady improvement in Soviet tactical aircraft, which have progressed from being a predominately defensive force to one with improved offensive capabilities. In fact, the latest generation of Soviet tactical aircraft is more complex than its American counterparts. Soviet fighters today, including the MIG-27 Flogger and the Su-24 Fencer, have improved maneuverability, extended range, and upgraded avionics and weapons. Moreover, the Fencer, like the MIG-25M Super Foxbat, carries a weapons officer in the two-seat cockpit. The most striking change in Soviet aircraft design is the fact that all but one of the latest generation of Soviet fighters have variable-geometry wings. This adds both complexity and cost to the airplanes and makes them more difficult to maintain.

In the latest American airplanes, including the F-15, F-16, and F-18, the incremental improvement in performance afforded by variable-geometry wings was abandoned in favor of less costly and more reliable aircraft, an important consideration generally overlooked by critics of American military designers. This example also illustrates the underlying assumption of the offset strategy: that technology should be applied only when it yields significantly superior war-fighting capability.

In line with this strategy, the United States may derive important lessons from the simulated-combat exercises held at Nellis Air Force Base in 1977. These exercises demonstrated that in close-range, "dogfight" situations, numbers of aircraft are crucial. Incremental increases in aircraft performance simply do not offset a four-to-one difference in numbers. Therefore, in addition to procuring more airplanes, the United States should develop weapons and strategies to minimize the risk of having to engage in dogfights when outnumbered. With superior tactical intelligence, U.S. pilots can avoid situations where they are outnumbered. With the means to attack multiple targets at long ranges, pilots can reduce the numerical disadvantage before they reach dogfight range.

Although U.S. pilots will inevitably encounter some dogfights, improved intelligence and air-to-air missiles can act as powerful equalizers. The key to this approach is the transfer of technological sophistication from the airplane to its weapons. Thus, F-16s procured in large quantities may be preferable to fewer numbers of the more formidable F-15 if the F-16s are equipped with improved air-to-air missiles.

Two technologies are critical to the ability of the United States to maintain a performance edge in air

combat. First, the U.S. can achieve an advantage in the avionics equipment that gives pilots "situation awareness," informing them of the type and location of all aircraft in their battle space. This information can be displayed electronically and updated every few seconds. Such situation awareness requires a combination of advanced systems, including an airborne warning and control system (AWACS), navigational satellites, and digital data-communications systems that relay the data from collection centers to individual pilots.

A second advantage will be provided by the next generation of air-to-air missiles, particularly the Advanced Medium-Range Air-to-Air Missile (AMRAAM), which marks a revolutionary advance from present technology. With advanced terminal guidance and signal-processing techniques, AMRAAM has a high probability of making a direct hit on low-flying targets despite the presence of sophisticated electronic countermeasures. Moreover, its longer range enables pilots to intercept simultaneously three or four enemy airplanes beyond visual range. Consequently, AMRAAM allows pilots to engage multiple enemy fighters before the fighters engage them. This missile is much more impressive than the Sidewinder missile, which functions like an advanced machine gun and is primarily useful in one-on-one encounters. Thus, even if U.S. tactical fighter forces were outnumbered in a particular theater, superior situation awareness would enable American pilots to avoid being outnumbered in their own locality. And AMRAAM allows them to operate in stand-off engagements instead of dogfights.

Sea Cruise

The fourth weapons category, naval developments, is particularly interesting because of the Reagan administration's proposal to move from a 450-ship navy to a 600-ship navy to offset the Soviet numerical edge in naval forces. We agree with the administration's objective of maintaining U.S. maritime superiority. But a more appropriate way of dealing with the Soviet surface navy would be to emphasize improved surveillance and cruise missiles.

Ocean surveillance implies the continuous tracking of Soviet surface ships in broad ocean areas. Presently, the United States is capable of monitoring Soviet vessels in moderate-sized areas using airborne radars such as AWACS and E-2C aircraft. This capability could be enhanced significantly by the use of both infrared and radar surveillance satellites.

Once a ship is located, the best means of attack is not with another ship but with a cruise missile, as demonstrated by the Argentinian use of the Exocet missile against the British frigate *Sheffield* in the Falkland Islands dispute. Indeed, the cruise missile has rendered direct ship-to-ship combat obsolete. The Tomahawk antiship cruise missile, currently in production, has five times the range of its predecessor and will make a vital contribution to the U.S. Navy's sea-control mission.

American cruise missiles are vastly superior to their Soviet counterparts. Soviet cruise missiles resemble unmanned jet airplanes, each weighing more than 20,000 pounds. For example, the Soviet AS-3 air-launched cruise missile is approximately the same size and weight as the U.S. F-5 tactical fighter. In sharp contrast, American cruise missiles are designed to make maximum use of miniaturized electronics and very efficient minijet engines and weigh about 3,000 pounds. Thus, the United States can put 20 cruise missiles on a B-52 bomber, whereas the Soviets can put only 2 of their cruise missiles on a Backfire bomber. This enormous military and cost advantage stems directly from superior technology.

The formidable fleet of Soviet submarines poses a serious threat to America's surface navy and sea lines of communications. The Soviet two-to-one quantititative advantage in submarines is partially offset by the fact that U.S. submarines have substantially superior performance. Even more important is the superior stealth of U.S. submarines, which are significantly quieter than their Soviet counterparts. This allows the United States to detect Soviet submarines at several times the ranges at which the Soviet Union can detect American submarines. Finally, more advanced U.S. detection technology, particularly long-range acoustic systems and refined signal-processing and data-integration techniques, greatly increases America's advantage.

More Technology, Less Complexity

Most of these defense technologies are based on advances in the fields of microelectronics and computer technology, where the United States enjoys approximately a five-year lead over the Soviet Union. Determined to maintain this edge, the Department of Defense has focused its research and development efforts on very high speed integrated circuits (VHSIC). Over the next four to five years, the Pentagon will

The Soviets are trying to close the gap in microelectronics and computers by copying Western technology.

invest approximately $300 million in VHSIC, and this does not include a comparable investment by private corporations. The purpose of this program is to advance the date by which advanced microelectronics will be incorporated into weapons systems. The circuitry will make weapons more reliable, since the number of connections among integrated circuits will be reduced. The program will also result in major savings in circuitry cost, weight, size, and power.

Although the Soviet Union has built devices with integrated circuits, Soviet shortcomings in software and manufacturing techniques are a major impediment to establishing a large-scale computer industry. Furthermore, the Soviets are trying to close the gap in microelectronics and computers by "reverse engineering" Western technology. To maintain the U.S. lead in this crucial area, the Defense Department has tightened controls on the transfer of critical technology and "keystone" equipment to Soviet-bloc countries. These controls have not been completely effective: circuits have been shipped out of the country illegally and are often available from sources outside the U.S. However, as long as the Soviets persist in their efforts to copy U.S. technology, and the United States continues to develop new technology, the Soviets will remain in a "tailchase" mode.

Although technological innovations such as VHSIC are often the key to finessing Soviet quantitative superiority, it is becoming fashionable to deride advanced American technology as being too expensive, difficult to operate and maintain, and unreliable. However, these critics display a lack of insight into the potential of modern technology: they identify as a problem what is America's best hope for a solution.

Many of the problems they describe in operating and maintaining military hardware can be traced to complex electromechanical devices used in equipment prior to the microelectronics revolution. Anyone who has operated a hand-held, solid-state calculator realizes that the difference between it and the desk calculator it replaced is not simply in performance—ease of operation and maintenance, reliability, and durability have all been significantly increased. Defense procurement programs are gradually replacing older, complex electromechanical systems with modern, solid-state microelectronics equipment.

This same technology is also being used to make various types of simulators that are revolutionizing the training of pilots and other equipment operators. Computer simulators recreate, at a reasonable cost, the fast-paced combat conditions that are often too dangerous and expensive to duplicate in reality. These simulated two-sided combat scenarios, similar to video games, will lead to vast improvements in operator proficiency and help reduce what Clauswitz has called the "friction of war."

The notion that such technology increases equipment cost has no basis in reality—complexity, not technology, is the culprit. In fact, almost every category of consumer purchases *except* electronics has seen a tenfold increase in price in the last few decades. In 1950, a black-and-white television set listed for about $500; a better set today may be purchased for less than $100. Even a more sophisticated color set runs about $500. Similarly, the cost of a calculator has been reduced from $1,000 for the 1960s model to $10 for today's solid-state model. And computers have gone from a few million dollars to a few tens of thousands of dollars for equivalent capability. Thus, the selective application of electronics is the key to limiting defense costs.

The B-1 bomber illustrates the need to distinguish between military effectiveness and technological sophistication. The original B-1 was designed with a supersonic capability that added greatly to its cost and complexity but contributed only marginally to its improved survivability. In fact, dropping the supersonic requirement not only decreased cost and complexity but probably increased net survivability. It allowed the size of the engine air-intake system to be

reduced, which in turn led to a reduction in its radar cross-section, making the aircraft more difficult to detect. Similarly, most commercial airlines have elected to forego the supersonic option because the benefit of reduced flight time does not offset the liability of increased costs and reduced passenger loads. Thus, wide-body subsonic transports are a commercial success, while the supersonic Concorde has proven to be uneconomical.

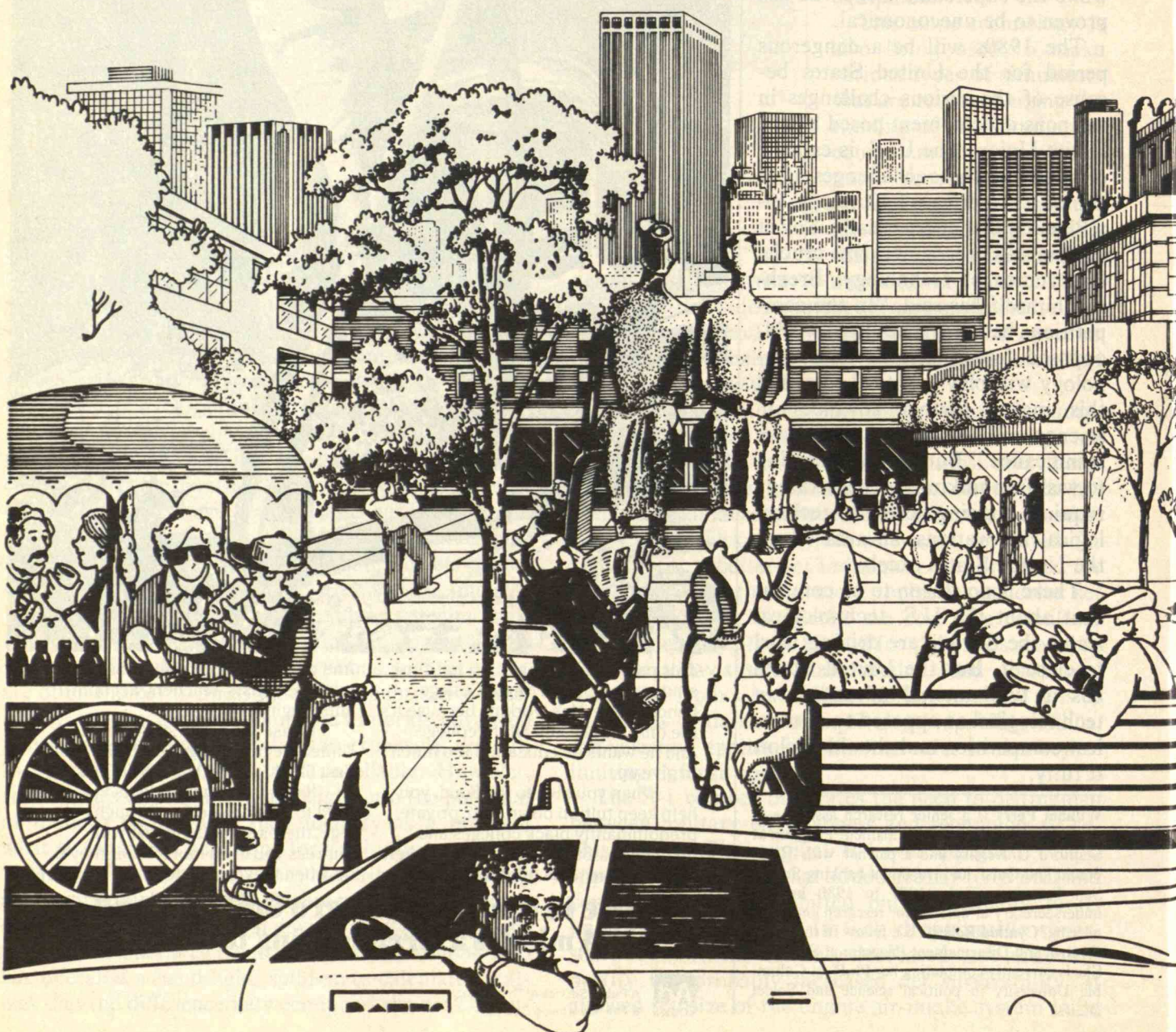
The 1980s will be a dangerous period for the United States because of the serious challenges in weapons development posed by the Soviet Union. The U. S. is capable of meeting these challenges if it exploits American technology intelligently and energetically. Soviet leaders also recognize the crucial importance of technology. Brezhnev himself has said, "In the competition between the two world-opposed forces, science and technology will play a critical role, and this makes further advances in science and technology of decisive significance." But he was resorting to wishful thinking: such a strategy requires ongoing access to technological innovations, an area where the United States excels.

There is no reason to be complacent about the U.S. technological lead—the Soviets are driving hard to close it. But the United States has a fundamental advantage in technological as opposed to numerical competition and should exploit it fully.

William Perry is a senior research associate in the Arms Control and Disarmament Program at Stanford University and a partner with Hambrecht and Quist, an investment banking firm in San Francisco. From 1977 to 1980 he was undersecretary of defense for research and engineering. **Cynthia Roberts** is a fellow in the Arms Control and Disarmament Program at Stanford. She is currently completing her Ph.D. at Columbia University in political science and Soviet affairs.

Small Space Is Beautiful:

The successful design of small urban spaces ultimately depends on watching the "experts"—people—using them.



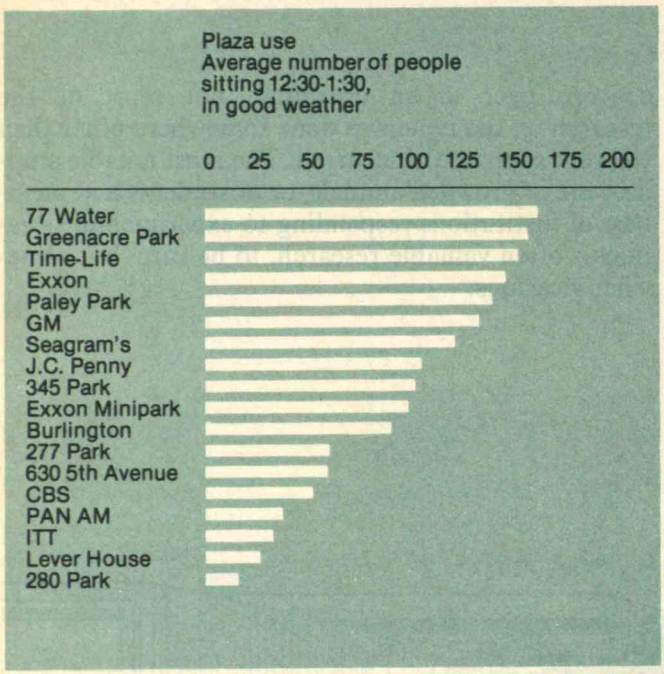
ILLUSTRATIONS: MICHAEL G. COBB

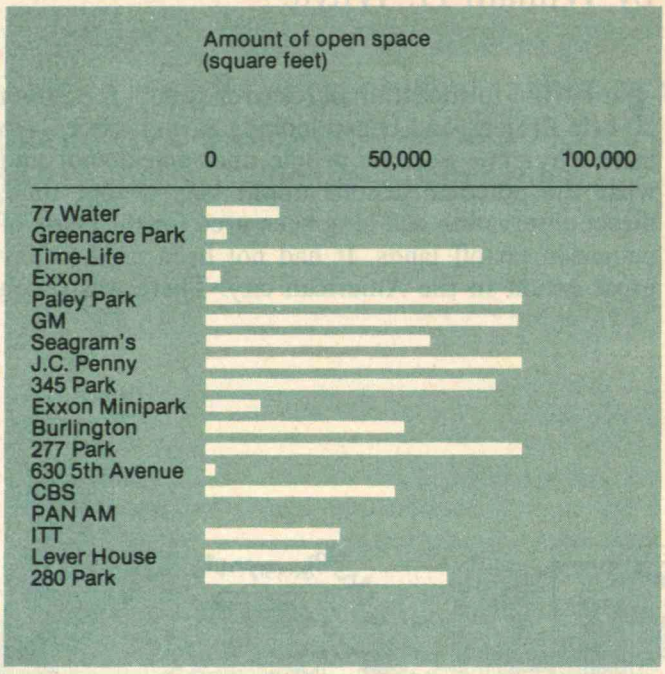
Design as if People Mattered

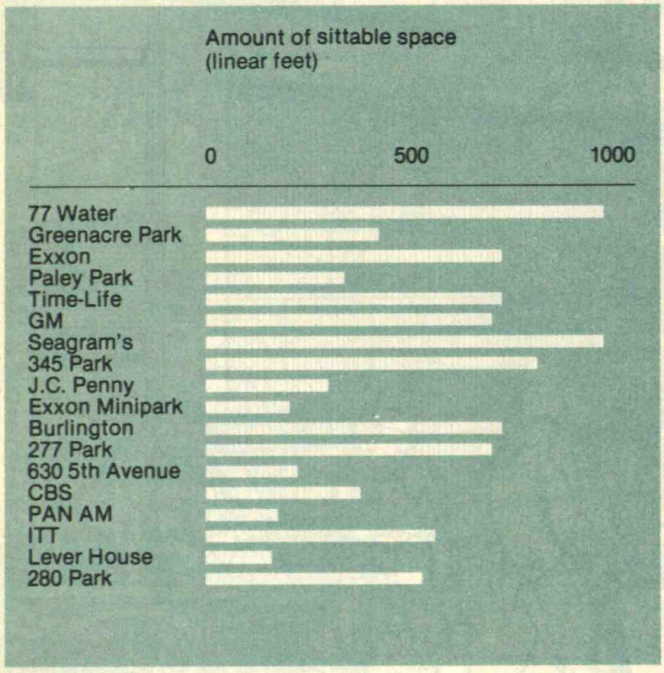
by William H. Whyte

In 1970, I formed a small research group, the Street Life Project, and began looking at city spaces—to learn why some work for people, and some do not, and what the practical lessons might be. At that time, direct observation had long been used for the study of people in far-off lands. It had not been used to any great extent in the American city. There was much concern over urban crowding, but most of the research on the issue was done somewhere other than where it supposedly occurred. The most notable studies were of crowded animals, or of students and members of institutions responding to experimental situations—often valuable research, to be sure, but somewhat vicarious.

The most attractive fountains, the most striking designs, cannot induce people to come and sit if there is no place to sit.







The Street Life Project began its study by looking at New York City parks and playgrounds and such informal recreation areas as city blocks. One of the first things that struck us was the *lack* of crowding in many of these areas. A few were jammed, but more were nearer empty than full, often in neighborhoods that ranked very high in density of people. Sheer space, obviously, was not itself attracting children. Many streets were.

It is often assumed that children play in the street because they lack playground space. But many children play in the streets because they like to. One of the best play areas we came across was a block on 101st Street in East Harlem. It had its problems, but it worked. The street itself was the play area. Adjoining stoops and fire escapes provided prime viewing across the street and were highly functional for mothers and older people. There were other factors at work, too, and, had we been more prescient, we could have saved ourselves a lot of time spent later looking at plazas. Though we did not know it then, this block had within it all the basic elements of a successful urban place.

As our studies took us nearer the center of New York, the imbalance in use of space was even more apparent. Most crowding could be traced to a series of choke points—particularly subway stations. In total, these spaces constitute only a fraction of downtown, but the number of people using them is so high and their experience so abysmal that it colors our perception of the city out of all proportion. The fact that there may be lots of empty space somewhere else little mitigates the discomfort.

This phenomenon affects researchers, too. We see what we expect to see, and have been so conditioned to see crowded spaces in center city that it is often difficult to see empty ones. But when we looked, there they were.

Furthermore, the amount of space was increasing. Since 1961, New York City has given incentive

PHOTOGRAPHS: WILLIAM WHYTE

When people stop to talk, whether on a plaza or in the street, they usually do so in the middle of the pedestrian traffic stream.

bonuses to builders who provide plazas. For each square foot of plaza, builders can add 10 square feet of commercial floor space over and above the amount normally permitted by zoning. So they have—without exception. Every new office building we studied provided a plaza or comparable space: by 1972, some 20 acres of the world's most expensive open space.

We discovered that some plazas, especially at lunchtime, attracted a lot of people. One, the plaza of the Seagram Building, helped give the city the idea for the plaza bonus. Built in 1958, this austerely elegant area was not planned as a people's plaza, but that is what it became. On a good day, there would be a hundred and fifty people sitting, sunbathing, picnicking, and shmoozing—idly gossiping, talking "nothing talk." People also liked 77 Water Street, known as "swingers" plaza because of the young crowd that populated it.

But on most plazas, we didn't see many people. The plazas weren't used for much except walking across. In the middle of lunch hour on a beautiful, sunny day, the number of people sitting on plazas averaged four per 1,000 square feet of space—an extraordinarily low figure for so dense a center. The tightest-knit CBD (central business district) anywhere contained a surprising amount of open space that was relatively empty and unused.

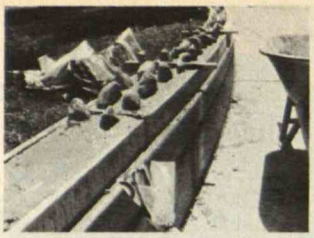
If places such as Seagram's and 77 Water Street could work so well, why not the others? We began studying a cross-section of spaces—in all, 16 plazas, 3 small parks, and a number of odds and ends. We mounted time-lapse cameras and recorded daily patterns. We talked to people to find where they came from, where they worked, how frequently they used the place, and what they thought of it. But mostly we watched people to see what they did.

There were a lot of false starts and dead ends, and the research was nowhere as tidy and sequential as in the telling. The findings would also have been staggeringly obvious had we though of them in the first place. But we didn't. Often, what seemed plainly evident turned out to be incorrect. We arrived at our findings by a succession of busted hypotheses.

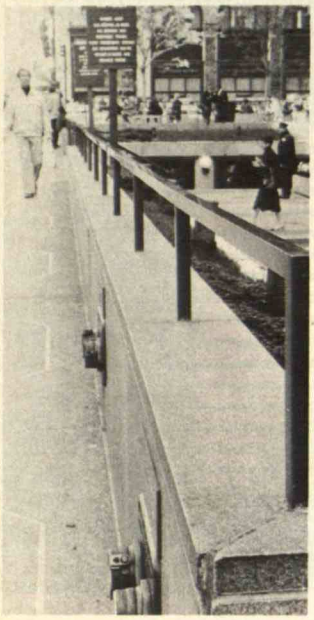
Patterns of the People

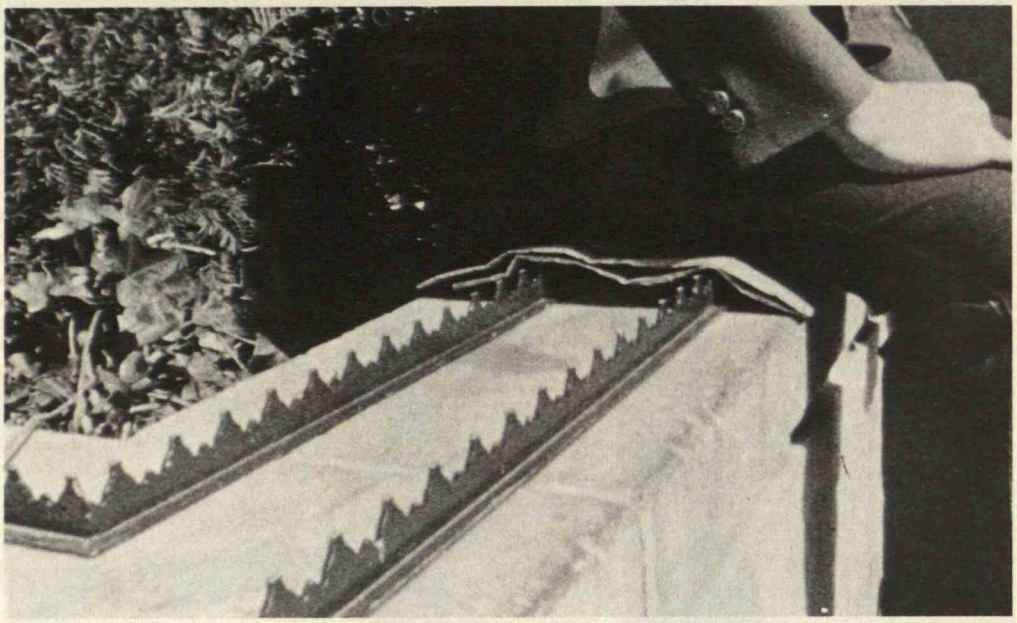
The best-used plazas are sociable places, with a higher proportion of couples than you find in less-used places, more people meeting people or exchanging goodbyes. A high proportion of people in groups is an index of selectivity. When people go to a place in twos or threes or rendezvous there, it is most often because they have decided to. Nor are these sociable places less congenial to the individual—they attract more individuals than less-used spaces. If you are alone, a lively place can be the best place to be.

What attracts people most, it would appear, is other people. But many urban spaces are being designed as though the opposite were true. People often do talk along such lines; this is why their responses to questionnaires can be so misleading. How many people would say they like to sit in the middle of a crowd?



"A dimension architects seem to have forgotten is the human backside. Rarely will you find a ledge that is sittable on both sides. Most ledges are inherently sittable, but with a little ingenuity and additional expense they can be made unsittable."





Instead, they speak of getting away from it all, and use terms such as "escape," "oasis," and "retreat." What people do, however, reveals another priority.

This was first brought home to us in a study of street conversations. When people stop to have a conversation, we wondered, how far away do they move from the main pedestrian flow? People didn't move out of it. They stayed in or moved *into* it, and the great bulk of the conversations were smack in the center of the flow. The same gravitation characterized "traveling conversations"—the kind in which two people move about, alternating the roles of "straight man" and principal talker. Although there is a lot of apparent motion, if you plot the orbits, they turn out to be quite restricted.

People also sit in the mainstream. At the Seagram plaza, the main pedestrian paths are on diagonals from the building entrance to the corners of the steps. These are natural junction and transfer points and the site of lots of activity. They are also a favored place for sitting and picnicking. Sometimes there will be so many people that pedestrians have to step carefully to negotiate the steps. The pedestrians rarely complain. While some will detour around the blockage, most will thread their way through it.

Standing patterns are similar. When people stop to talk on a plaza, they usually do so in the middle of the traffic stream. They also show an inclination to station themselves near objects such as a flagpole or a statue. They like well-defined places such as steps or the border of a pool. What they rarely choose is the middle of a large space.

Whatever they may mean, people's movements are one of the great spectacles of a plaza. You do not see this in architectural photographs, which typically are empty of life and taken from a perspective few people share. It is a quite misleading one. At eye level the scene comes alive with movement and color—people walking quickly, walking slowly, skipping up steps, weaving in and out on crossing patterns, accelerating and retarding to match the moves of others. There is a beauty that is beguiling to watch, and one senses that the players are quite aware of it themselves. You see this, too, in the way they arrange themselves on steps and ledges—they often do so with grace. With its brown-gray monochrome, Seagram's is the best of settings—especially in the rain, when an umbrella or two adds color in the right places, like Corot's red dots.

How peculiar are such patterns to New York? We assumed that behavior in other cities would probably differ little, and subsequent comparisons proved our assumption correct. The important variable is city size—the strongest similarities are found among the world's largest cities. People tend to behave more like their counterparts in other world cities than like fellow nationals in smaller cities. Big-city people walk faster, for one thing, and they self-congest. After we had completed our New York study, we made a brief comparison study of Tokyo and found that the proclivity to stop and talk in the middle of department-store doorways, busy corners, and the like is just as

Rules for Regulators

Ledges ought to be "sittable." But how should this be defined? If we wanted sittable ledges in the New York City zoning amendments, we thought we would have to indicate how high and deep ledges should be and then back up the specifications with facts.

The zoning proceedings during 1974 were unexpectedly adversarial. The attack came on the grounds that the zoning was *too specific*. And it came not from builders, but from members of a local planning board. Rather than spell out the requirements in specific detail, the board argued, the zoning should deal with broad directives—for example, "make the place sittable"—and leave details to be settled on a case-by-case basis.

This argument is persuasive, especially for laypeople, and, at the inevitable moment in zoning meetings when someone gets up and says, "Let's cut through all this crap and get down to basics," everyone applauds. Be done with bureaucratic nitpicking and legal gobbledygook.

But ambiguity is a worse problem. Most incentive zoning ordinances are very, very specific as to what developers get. The trouble is that they are mushy as to what they are to give, and mushier yet as to what will happen if later they don't. Vague stipulations, as many cities have learned, are unenforceable. What you do not prescribe quite explicitly you do not get.

This lack of guidelines does not give buildings and architects more freedom; it reinforces convention. That is why so few good plazas were built under the 1961 zoning resolution. There was no law preventing builders from providing better plazas, but there weren't any guidelines either. And most builders do not do anything far out of the ordinary. A few had sought special permits for amenities not countenanced by existing regulations. But this time-consuming route makes the builder and architect run a gauntlet of city agencies, with innovation as likely to be punished as rewarded.—*W.H.W.* □

strong as in New York.

For all the cultural differences, sitting patterns in various parks and plazas around the world are much the same, too. Similarly, shmoozing patterns in Milan's Galleria are remarkably like those in New York's garment center. The modest conclusion: given the basic element of a center city—such as high pedestrian volumes and the concentration and mixture of activities—people in one place tend to act much like people in another.

The Bottom Line

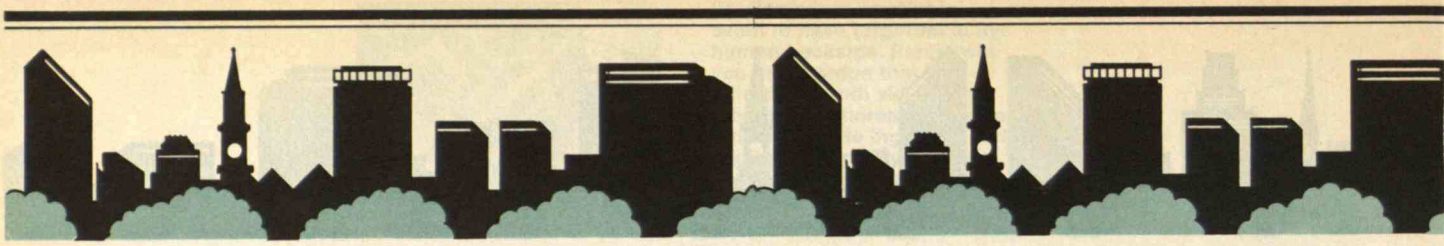
In their use of plazas, New Yorkers were very consistent. Day in, day out, many of them would sit at certain plazas, few at others. On the face of it, there should not have been this variance—most of the plazas we were studying were fairly comparable. With few exceptions, they were on major avenues and usually occupied a block front. They were close to bus stops and subway stations and had strong pedestrian flows on the sidewalks beside them. Yet when we rated plazas according to the number of people sitting on them at peak time, there was a very wide range—from 160 people at 77 Water Street to 17 at 280 Park Avenue (*see the upper-left chart on page 38*).

How come? The first factor we studied was the sun. We thought it might well be the critical one, and our initial time-lapse studies seemed to bear this out. Subsequent studies did not. As I will note later, they showed that the sun was important but did not explain the difference in the popularity of plazas. Nor did aesthetics. The elegance and purity of a building's design seems to have little relationship to the use of the spaces around it. The designer sees the whole building—the clean verticals, the horizontals, the way Mies van der Rohe turned his corners, and so on. People sitting on the plaza may be quite unaware of such matters. They are more apt to be looking in another direction: not up at other buildings, but at what is going on at eye level.

Another factor we considered was shape. Urban designers believed this was extremely important and hoped our findings might support tight criteria for proportion and placement. Our data did not support such criteria, but neither did they prove shape unimportant or designers' instincts misguided. As with the sun, however, they did prove that other factors are more critical.

If not shape, could the *amount* of space be the key factor? Some conservationists were sure this would be it. In their view, people seek open spaces as a relief from the overcrowding they are normally subjected to, and it would follow that places affording the greatest feeling of light and space would draw the most. Once again, we found no clear relationship. As can be seen from the upper-right chart on page 38, sheer space does not draw people. In some circumstances, it can have the opposite effect.

What about the amount of *sittable* space? Here we begin to get close. As the lower chart on page 38 shows, the most popular plazas tend to have a lot more



Open Seating

A wonderful invention is the movable chair. Having a back, it is comfortable; more so if it has an armrest as well. But the big asset is movability. Chairs enlarge choice: to move into the sun or out of it; to make room for groups or move away from them. The possibility of choice is as important as the exercise of it. If you know you can move if you want to, you feel more comfortable staying put. That is why, perhaps, people so often move a chair a few inches this way and that before sitting on it, with the chair ending up about where it was in the first place. The moves are functional, however. They are a declaration of autonomy, to oneself, and rather satisfying.

Small moves say things to other people. If a newcomer chooses a chair next to a couple or a larger group, he may make some intricate moves. Again, he may not take the chair very far, but he conveys a message. Sorry about the closeness, but there's no room elsewhere, and I am going to respect your privacy, as you will mine. A reciprocal move by one of the others may follow. Watching these exercises in civility is itself one of the pleasures of a good place.

Fixed individual seats are not good. They are a design conceit. Brightly painted and artfully grouped, they can make fine decorative elements: metal loveseats, revolving stools, squares of stone, sitting stumps. But they are set pieces. Social distance is a subtle measure, ever changing, and the distances of fixed seats do not change, which is why they are rarely quite right for anybody. Loveseats may be all right for lovers, but they're too close for acquaintances, and much too close for strangers. Loners tend to take them over, placing their feet squarely on the other seat lest someone else sit on it.

Fixed seats are awkward in open spaces because there's so much space around them. In theaters, strangers sit next to one another without qualm; closeness is a necessity, and convention makes it quite tolerable. On plazas, the closeness is gratuitous. With so much space around, fixed-seat groupings have a manipulative cuteness to them. The designer is saying, now you sit right here and you sit there. People balk. In some instances, they wrench the seats from their moorings. Where there is a choice between fixed seats and other kinds of sitting, it is the other that people choose.

To encourage the use of

sitting space than the less well used ones, but the relationship is rough. For one reason, the amount of sitting space does not include any qualitative factors: a foot of concrete ledge counts for as much as a foot of comfortable bench space. We considered weighing the data on a point basis—so may points for a foot of bench with backrest, with armrests, and so on. This would have produced a nicer conformance on the chart. We gave up the idea, however, as too manipulative. Once you start working backward this way, there's no end to it.

There was no necessity. No matter how many variables we checked, one point kept coming through:

People tend to sit most where there are places to sit.

This may not strike you as an intellectual bombshell, and, now that I look back on our study, I wonder why it was not more apparent from the beginning. Sitting space, to be sure, is only one of many variables, and without a control situation one cannot be sure of cause and effect. But sitting space is most certainly prerequisite. The most attractive fountains, the most striking designs, cannot induce people to come and sit if there is no place to sit.

Design with Human Nature

Ideally, sitting should be physically comfortable—benches with backrests, well-contoured chairs. However, it's most important that it be *socially* comfortable. This means a choice: to sit up front, in back, to the side, in the sun, in the shade, in groups, off alone.

Choice should be built into the basic design. Even though benches and chairs can be added, the best course is to maximize the "sittability" of inherent features. This means making ledges that are sittable or making other flat surfaces do double duty as tabletops or seats. There are almost always such opportunities. Because the elevation changes somewhat on most building sites, there are bound to be several levels of flat space—it is no more trouble to make them sittable than not to. It takes real work to create a lousy place. Ledges have to be made high and bulky, railings put in, surfaces canted. Money can be saved by not doing such things, and the open space is more likely to be amenable.

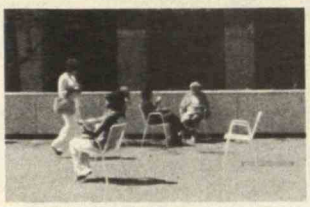
A dimension architects seem to have forgotten is the human backside. Rarely will you find a ledge or bench deep enough to be sittable on both sides; some aren't deep enough to be sittable on one. Most frustrating are the ledges just deep enough to tempt people to sit on both sides, but too shallow to let them do so comfortably.

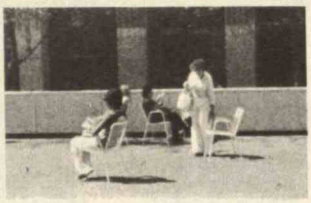
Thus to another of our startling findings: ledges and spaces two backsides deep seat more people comfortably than those that are not as deep. For a few additional inches of depth, then, builders can double the amount of sitting space. This does not mean that double the number of people will use the space, but that is not the point. The benefit of the extra space is social comfort—more room for groups and individu-

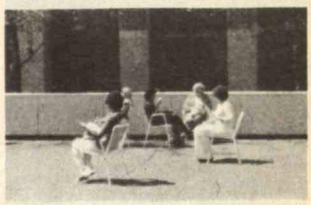
movable chairs, we recommended that in the New York zoning amendment they be credited as 30 inches of sitting space, though most are only about 19 inches wide. The Building Department objected. It objected to the idea of movable chairs at all. The department had the responsibility of seeing that builders lived up to requirements. Suppose the chairs were stolen or broken and the builder didn't replace them? Whether the department would ever check up in any event was a moot point, but the fewer such amenities to monitor, the easier the monitoring would be.

Happily, there was a successful record at Paley and Greenacre parks to point to, and it was persuasive. The chairs stayed in the amendment. They have become a standard amenity at new places, and the maintenance experience has been excellent. Managements have also been putting in chairs to liven up existing spaces, and even without incentives they have been adding more chairs. The most generous provider is the Metropolitan Museum of Art. Alongside its front steps, it puts out up to 200 movable chairs and it leaves them out, 24 hours a day, seven days a week. The Met figured that it might be less expensive to trust people and to buy replacements periodically rather than have guards gather the chairs in every night. That is the way it has worked out. There is little vandalism.—*W.H.W.* □

The impulse to move chairs, even if only a few inches, is very strong. It is a declaration of autonomy, as well as of respect for the privacy of others. "Watching these exercises in civility is one of the pleasures of a good place."







als to sort themselves out, more choices and more perception of choices.

Steps work for the same reason. The range of space provides an infinity of possible groupings, and the excellent sightlines make virtually all the seats great for watching the theater of the street. And corners are functional. You will notice that people often bunch at the far end of steps, especially when an abutting ledge provides a right angle. These areas are good for face-to-face sitting. People in groups gravitate to them.

One might, as a result, expect a conflict, for corners are also the places where pedestrian traffic is heaviest. But for all the bustle, or because of it, the sitters seem to feel comfortable. And the walkers don't seem to mind.

We find similar patterns at other places. Other things being equal, you can calculate that where pedestrian flows bisect a sittable place, that is where people will most likely sit. And it is not so perverse of them—it is by choice. If there is some congestion, it is an amiable one and a testimonial to the place. Circulation and sitting, in sum, are not antithetical but complementary. The easier the flow between street and plaza, the more likely people are to move between the two—and to tarry and sit.

This is true of the handicapped, too. If circulation and amenities are planned with them in mind, the place is apt to function more easily for everyone. Drinking fountains low enough for wheelchair users are low enough for children. Pedestrian paths that are made easier for the handicapped by ramps, handrails, and steps of gentle pitch are easier for all. The idea is to make all of a place usable for everyone.

Planned Enlightenment

The most satisfying film I've ever seen is our first time-lapse record of the sun passing across the Seagram plaza. In late morning, the plaza was in shadow. Then, shortly before noon, a narrow wedge of sunlight began moving across the plaza and, as it did, so did the sitters. Where there was sun, they sat; where there was none, they didn't. It was a perfectly splendid correlation, and I cherished it. Like urban designers, I believed a southern exposure to be of critical importance. Here was abundant proof.

Then something went wrong. The correlations vanished—not only at Seagram's but at other places we were studying. The sun still moved; the people didn't. At length the obvious dawned on us: May had been followed by June. While midday temperatures hadn't risen a great deal, the extra warmth was enough to make the sun no longer the critical factor.

It was about this time that much of Paley Park's sunlight began to be cut off by an office building going up across the street. From its scaffolding we focused time-lapse cameras on the park and recorded the effect of the new building. It was surprisingly little. Although the sunlight was curtailed, people used Paley as much as they had before. Perhaps they would have used it more had the sun remained; without studying an identical place as a control, one can

"With adroit design, sun can be 'borrowed.' The same new buildings that cast shadows also reflect considerable light."

The transition between street and plaza should be such that it's hard to tell where one ends and the other begins. Paley Park is the best example.

"The waterwall is loud, but in the park it is perceived as quite pleasant. It is white sound that masks the intermittent honks and bangs of street noise."

never be sure. The more important point is that, unfortunate as the loss may have been, the park was able to sustain it.

Access to the sun should be protected, of course, but places that have little or no sun because of a northern exposure or intervening buildings are not a lost cause. With adroit design, sun can be "borrowed." The same new buildings that cast shadows also reflect considerable light. Along with mirror walls, glass, and stainless steel, architects have been laying on travertine marble with a heavy hand, and light has been bouncing into many places that didn't receive it before. In eight years of filming, I have found that several streets have become photographically a half-stop faster. A number of open spaces that otherwise would be dark much of the time are bathed in reflected light, sometimes on the second or third bounce. Grace plaza, for example, gets no direct sun at all but benefits most of the afternoon from light reflected by the southern exposure of the building to the north. Give travertine its due. It bounces light admirably, especially in the late afternoon, when it can give a benign glow to the streetscape.

So far, such effects are wholly inadvertent. Sun studies made for big new buildings tend to be defensive, so that planning boards can be shown the building won't cast an awful lot more shadow than is cast already by other buildings. Few studies try to determine the light a new building will cast, what benefits might result, to whom, and when. Yet benefits of great potential value can be planned and negotiated in advance.

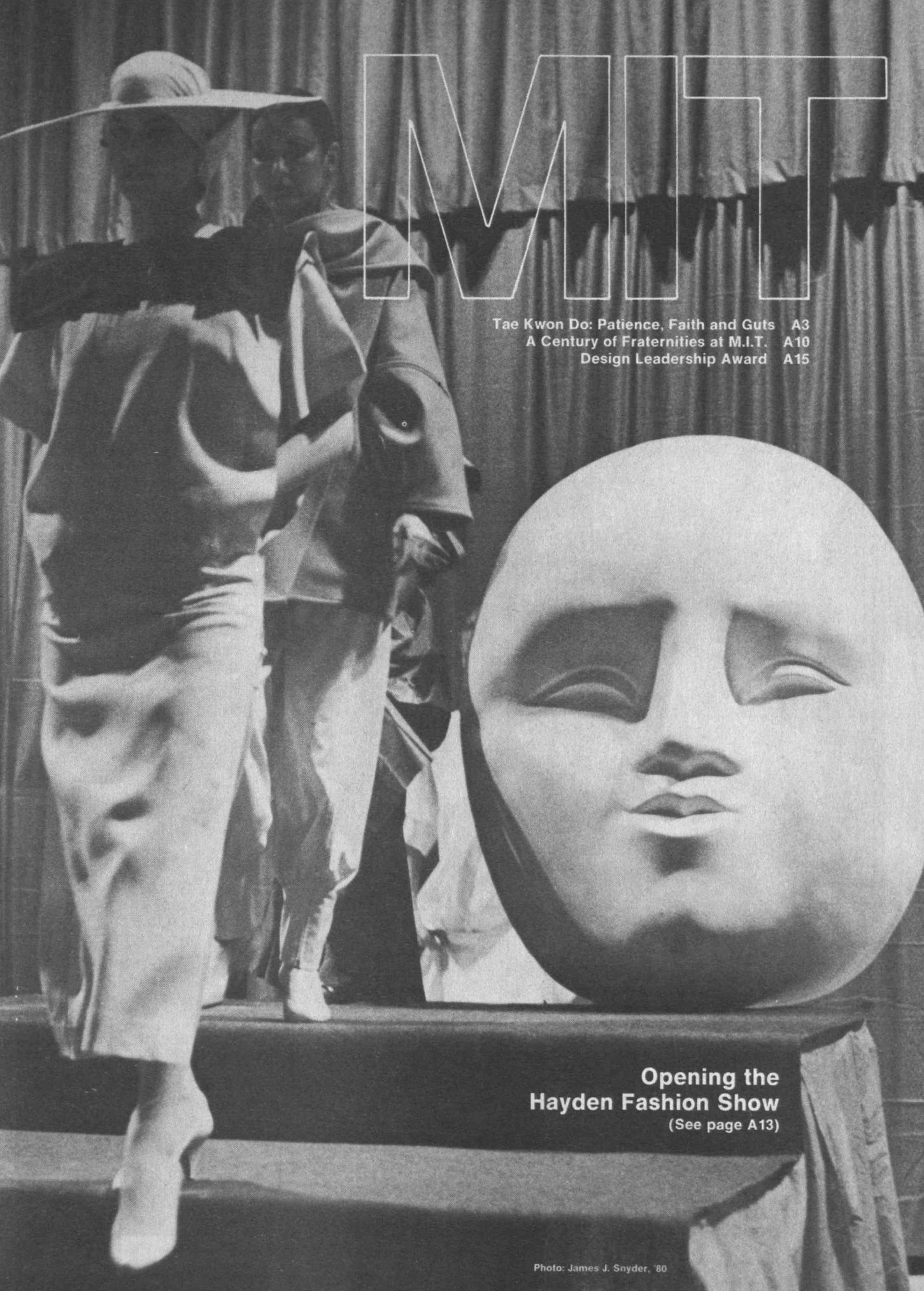
Wind and the Willows

What people seek are suntraps. And the absence of wind and drafts are as critical as sun. In this respect, small parks, especially those enclosed on three sides, function well. Physically and psychologically, they feel comfortable, and this is one of the reasons why their relative carrying capacity is so high. New York's Greenacre Park has infrared heaters, but they are used only in extremely cold weather. With sun and protection from wind, the park is quite habitable even on nippy days.

Spaces around new buildings are quite another matter. In winter, many are cold and drafty, and even in moderate weather few people tarry in such places. The errors are of omission. Wind-tunnel tests on models of new buildings are now customary, but they are not made with people much in mind. The tests for the World Trade Center largely determined stresses on the towers and the type of structural steel required. What the towers themselves might generate in the way of wind, and the effects on people below, apparently were not of much concern.

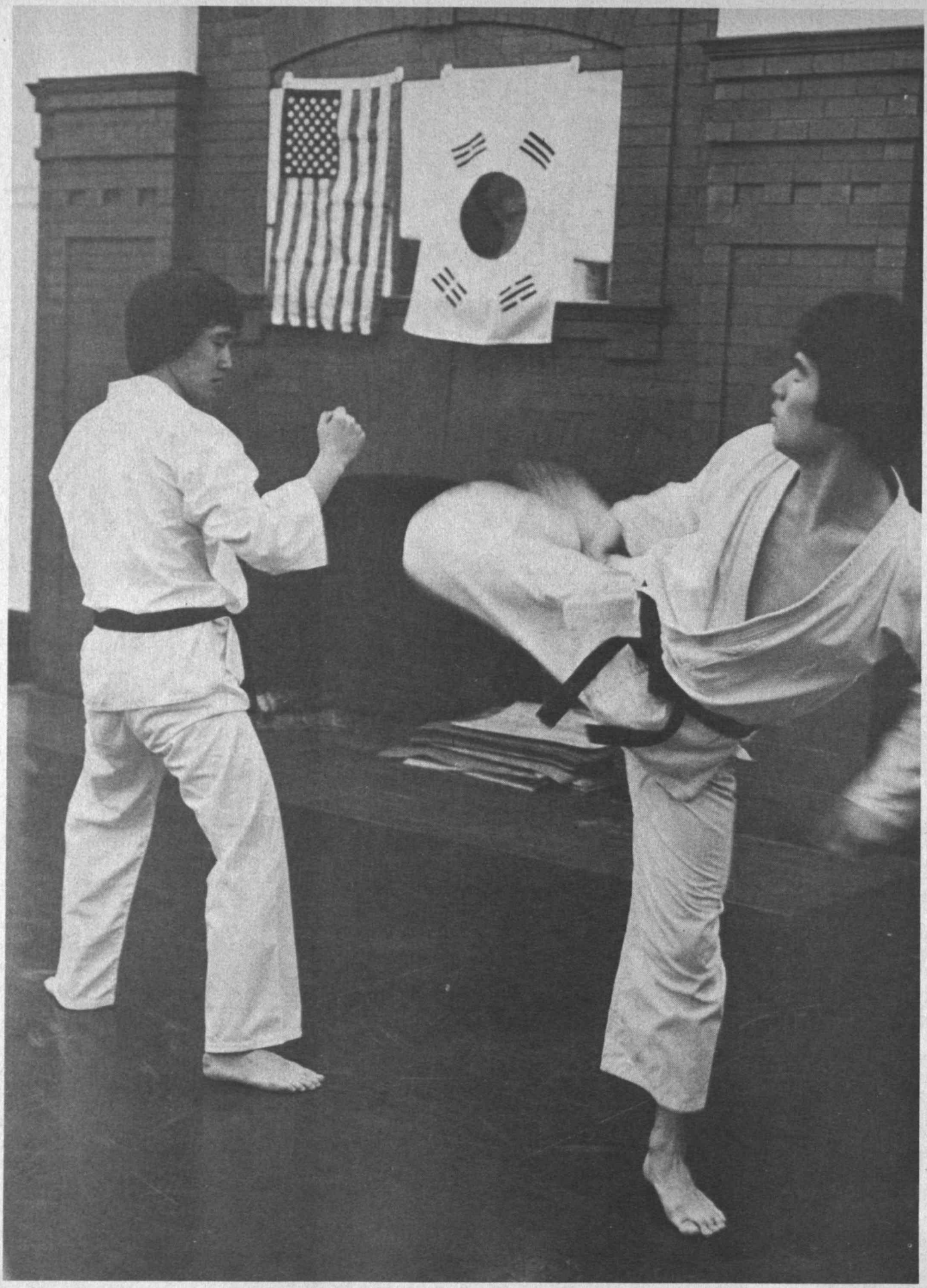
These effects, however, are quite measurable. It is now well established that very tall, free-standing towers can generate tremendous drafts down their sides. This fact has in no way inhibited the construction of such towers, with the predictable result that some spaces are frequently uninhabitable. At one bank pla-

MIT

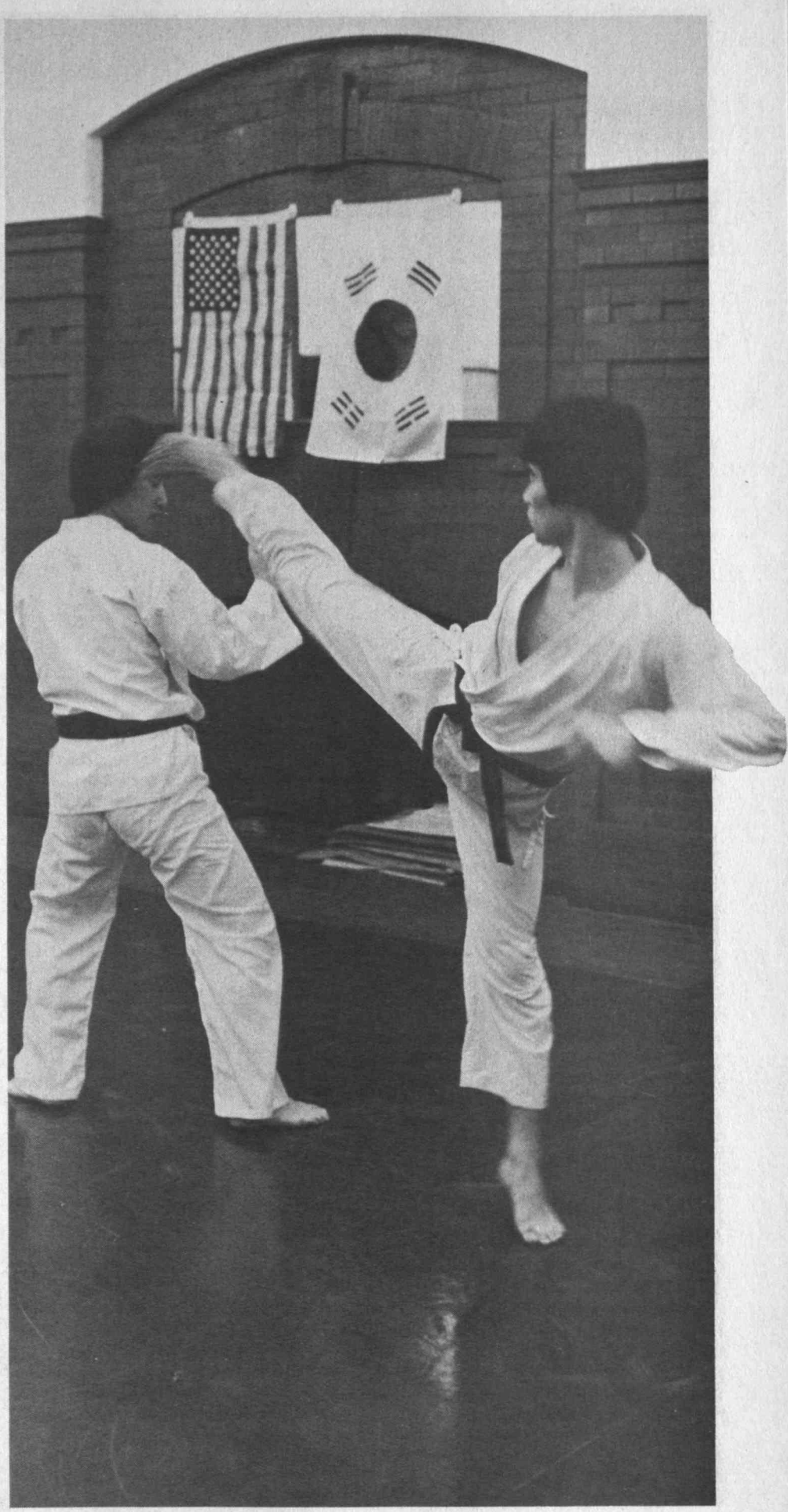


Opening the Hayden Fashion Show
(See page A13)

Photo: James J. Snyder, '80



Charles Park, graduate student (left) and Young Soo Ha, '85. The exercise allows each student to practice a roundhouse kick with a target. (Photos, pages A2-A7: James J. Snyder, '80)



Tae Kwon Do: Patience, Faith and Guts

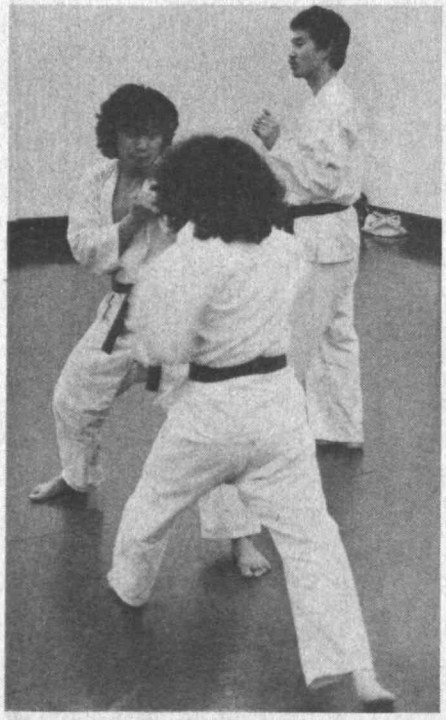
A clenched fist shoots forward, right hand front, left pulled back. A foot lifts high into the air, leg bent, then extended, kicking with the force of full body weight and pulling back instantly. A body flies through the air for a moment, one leg suddenly stretched out fully, kicking to the side.

"Cha-Ryoth!" an upper belt commands. The M.I.T. Tae Kwon Do Club snaps to attention for a moment, facing the door, monochrome in their traditional white uniforms as master Chung Sun Kang, fifth degree black belt, enters.

"Kyung Nae." As one, the class bows; then returns to pre-class warm up, a time for individual stretching and practicing.

This two-hour class (held four times a week) is in the T-Club lounge at du Pont Gymnasium. The light of bright fluorescents bounces off a shiny tile floor that reflects the movements of participants. A large mirror lines one wall; above an old wooden fireplace mantle in the front of the room are hung the American and Korean flags for the duration of the class.

Students must bow to the room, any upper belts present, and the flags as they enter. These formalities seemed foreign to me when I joined last January; now I see this ritual of respect and discipline as perfectly aligned with the art.



Master Chung Sun Kang, '81, (opposite page, right) demonstrates an isometric blocking motion done in slow motion; Mark Brent, '83, (opposite page, top) in back stance, inner palm block. This page: (top) Young Soo Ha, '85, is the attacking partner in a three-step sparring exercise. Above: Paul Bui, '84, and Jane Fine sharpen free sparring techniques.

I've left my worries, my to-do list, my psychic baggage at the door. There is no room for anything in class but to be there, follow instructions, and become the motions of my body.

"Line up!"

The chaos of individuals immersed in separate routines becomes ordered as the class springs into lines of four, upper belts in descending heirarchy from the front.

Young Soo Ha, '85, first degree black belt, walks to the front of the room.

"Kyung Nae." The class bows.

Exercises, first, to warm up: jumping jacks (200 perhaps at a time), sit-ups, push-ups, stretching, more of each in quick succession. Not for the weak of heart, this. The volume of grunts and sweat increases as time lengthens. Finally, the warm-up exercises come to a close.

Master Chung Sun Kang, fifth degree black belt, moves to the front of the room.

"Jhoon-Bee!" he barks.

The atmosphere in the room changes to one of intense energy. The class assumes a ready stance: breath pulled in and let out, arms bent at the elbows, fists in front at waist level, shoulders straight, feet apart at shoulder width.

"Riding stance punch. Ki-hap (yell)."

The ki-hap in unison is electric. Feet wide apart, knees bent, punch straight ahead, fists turned up when the arm is at your side, down when extended. Power is in the twist of the wrist and in the body movement.

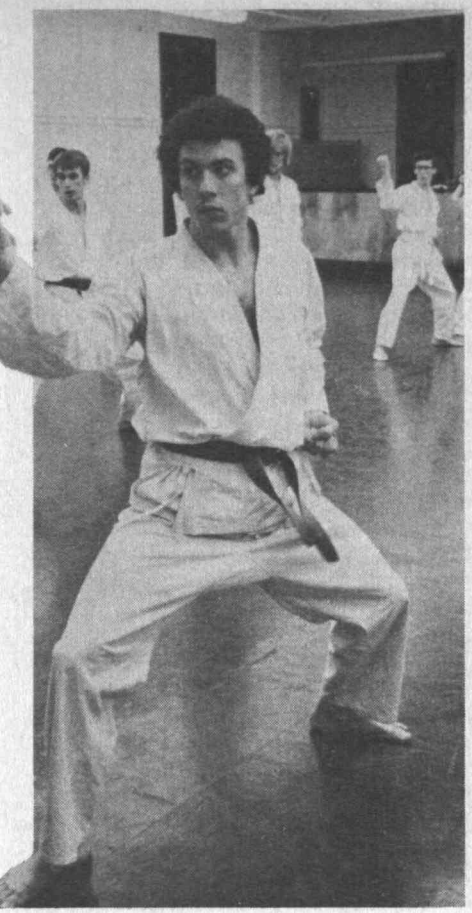
Master Kang announces the exercise and performs the motion an instant before the class imitates. His demeanor is quiet power and strength; his finesse and control awe inspiring. Why does he project that? I thought. He is not big and muscular as one might imagine, but has a thin 5'10" frame, his face with black hair and mustache an enigma until he smiles.

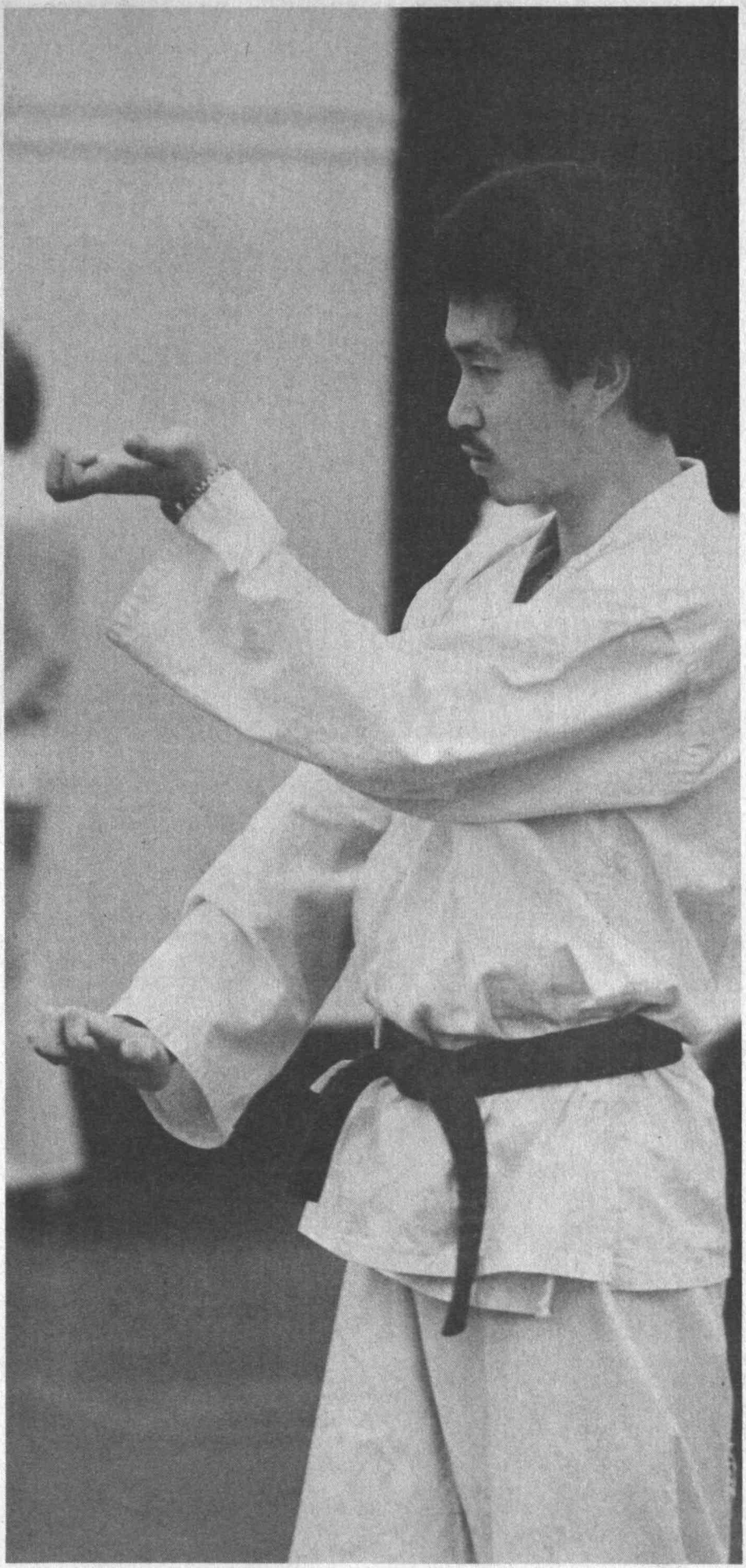
Cruising on Automatic Pilot

He talks to me later about his art: "The techniques in Tae Kwon Do are built into my habit—turning my waist, twisting my wrists. I realized after coming to M.I.T. and studying physics that the motions are very complicated; that it's a sophisticated form of art, not just physical exercise.

"Equilibrium is essential—the whole body should be balanced. When you punch, you always pull the other hand back, creating force in one direction while you create an opposite force for static equilibrium.

"The ki-hap is a basic part of concentration: when you shout, you totally forget anything inside your head; every-





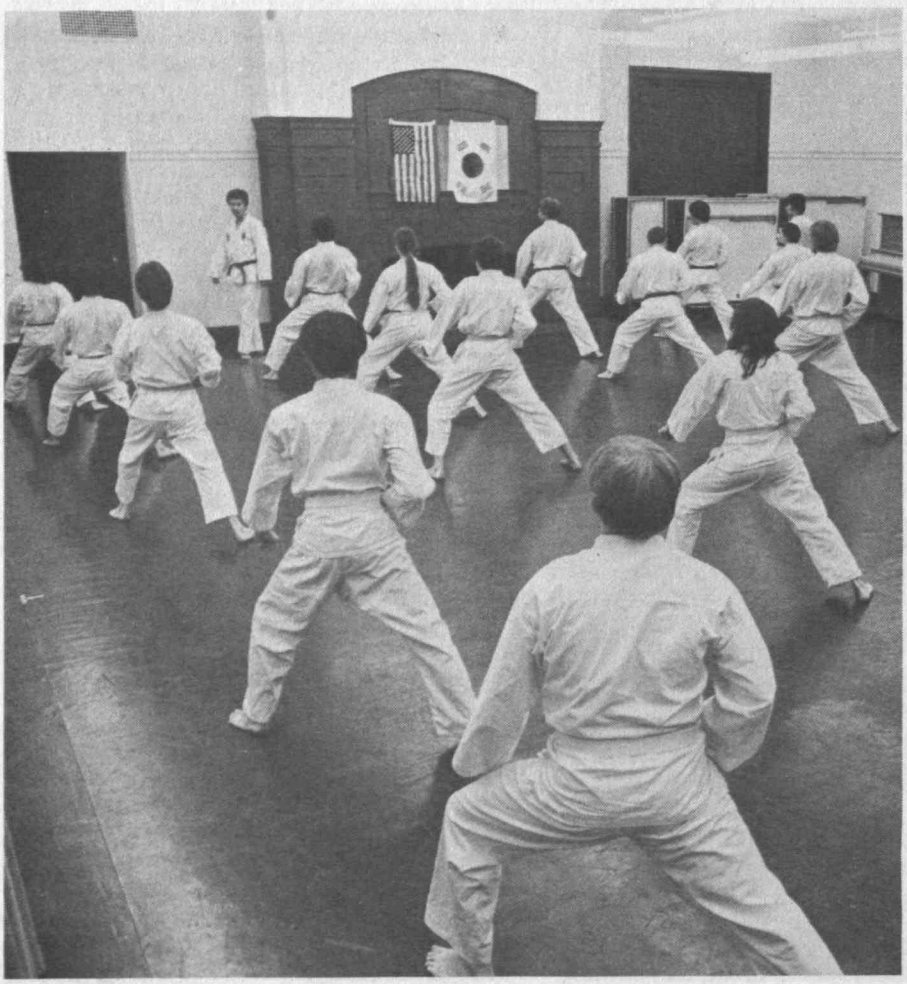
thing else goes away." He explained the translation of Tae Kwon Do from the Korean words: Tae means to jump, kick or smash with foot; Kwon denotes a fist or punch; Do means art, way, or method. So Tae Kwon Do describes a technique of unarmed combat for self defense using the skilled application of punches, kicks, blocks, and dodges.

The class is instructed to punch 50 times, each at his own speed. Ki-haps break the silence as each person completes the exercise.

Master Kang changes the practice to other basic techniques: front stretch, front kick, side kick, roundhouse kick. In the front row, upper belts are obviously more skilled; they demonstrate superior precision, concentration, power and speed. And they have another dimension that is apparent but not easily pinpointed . . .

Dark brown curls stick to a face shiny with sweat; a blue belt concentrates, brown eyes straight ahead, mouth set with effort. His punches and kicks are powerful and well controlled. Mark Brent, '84, talked to me about how his perceptions of Tae Kwon Do evolved with time:

"I joined solely because I was interested in self defense. But that changed. And my reason for being there is still evolving. I hadn't imagined it was a good physical workout. Then I was



amazed at how many facets of my physical well-being Tae Kwon Do developed—coordination, flexibility, strength, endurance, speed, balance.

"A big issue for me was discipline and respect. I was distrustful and skeptical of authority. This changed for me; I began to like it. I started loosening up; in life you constantly have to make decisions for yourself; here was a place that once I trusted and believed in the master I could cruise on automatic pilot and let go for a few hours. It was a release.

"Something else started happening: the fighting aspects became very toned down; other facets took on more meaning. The teachers were strong, but I could see that as people they were gentle. Yet my previous experiences were that the best athletes were the loudest, toughest, and strongest. I was intrigued; is there something about the art that causes this change in a person?

"I started watching the masters or high belts perform techniques; I realized how far I was from them. I became amazed that it was so difficult to master seemingly straightforward movements. My interest became simply to achieve mastery of the technique itself, in an isolated setting, with no reference to violence.

"I'm beginning to sense what I'm supposed to be doing. Becoming one with the motions, you express yourself through the art."

Physical and Spiritual

A green belt in the second row commands attention: his boyish athletic body moves with catlike grace. Paul Bui, '84, has studied Tae Kwon Do as a child in his native Viet Nam. He focuses intently on every motion; his concentration reveals a background in the martial arts.

He gropes for words to describe what Tae Kwon Do means to him: "In my old school in Viet Nam, Tae Kwon Do wasn't for defense so much as for something else; something deeper. Respect, I guess. Like religion, it developed a kind of strength; but physical instead of spiritual. When I was in Thailand for one and one-half years, I had the urge to do forms (choreographed sets of techniques from Tae Kwon Do), and then meditate—I'd go down to the basement of our house and work on them, just for myself. Studying the martial arts is a lifestyle, a journey," he told me, "not something you can come to; the thing itself is the ongoing thing, with no peak, no zenith. You can always move up."

Wednesday's class is taught by Anthony D'Amico, '83, first degree black belt. He pushes the class to test the limit of their physical endurance, and to push

them past it."The next belt is not so important as trying to learn something about *yourself*," he told me. "When you didn't think you could do something and you did, you take that out into the rest of your life. It's the attitude that serves you. Learn how to discipline yourself and that is with you forever. Those are things you can't buy."

Mark Brent agrees. "Ultimately there are some physical real-world limits," he told me. "But way before that we hit our *own* set limits. All these lessons may seem like 'yeah, I've heard that before,' but you have to *feel* what it's like. It has a whole new meaning for me, to understand on a gut level. Anthony has pushed me (by my choice) past what I was sure was my level of exhaustion. Now I've experienced it in one realm; and it extends to 'I'm too shy,' or 'I can't take on this project,' to 'I can't get out of bed.' These lessons are not just isolated to the two hours in class; I take them out into life.

The Strength of Confidence

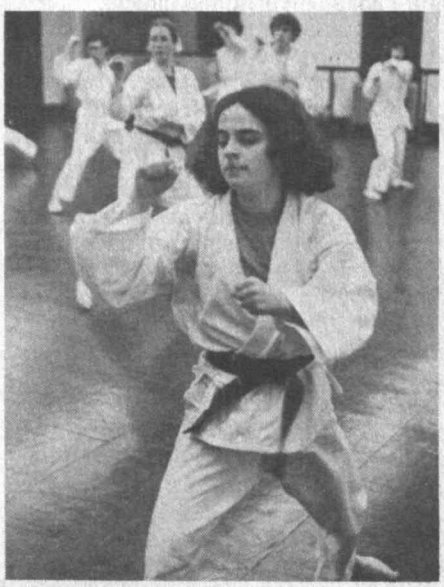
I sit on the lawn in front of Kresge and the chapel. This sunny Sunday is part of spring weekend and the grass is populated with hundreds of students. The Tae Kwon Do club is giving a demonstration in a clearing at one edge of the crowd.

Boards are held in the air for black belts to kick and break, three at once sometimes, before landing. The gymnastic feats of control, strength, and timing are impressive. In Ho Kim, '85, leaps across three bending students to break a board with a flying side kick. Some students demonstrate free sparring, using all the techniques, attacking and blocking.

I sit on the sideline and contemplate what Tae Kwon Do means to me. We share a hard workout and an avid interest in the perfection of a difficult skill. Perhaps more important to me is the strong sense of gentleness and respect among the students. How strange, you say! Aren't the martial arts equated with violence and macho? Not as I perceive it. Tae Kwon Do nurtures instead the development of a gentle, quiet demeanor whose bearer respects others and remains patient and calm in a crisis. Yet the strength is what allows this calm—there is nothing to prove. "I don't need to fight to test if I could win," Young Soo Ha told me.

I have just begun; my white belt has hardly become soiled in my four months of effort. My sense is one of being on the edge of a fascinating journey: beginning to learn the reasoning behind the stances, the excitement when the balance is real, the possible power in a punch done with correct form, the feeling of well-being that comes from a body that is strong and flexible, the satisfaction of a very difficult workout calling for every last ounce of energy—knowing that the accomplishment is greater than the time before.

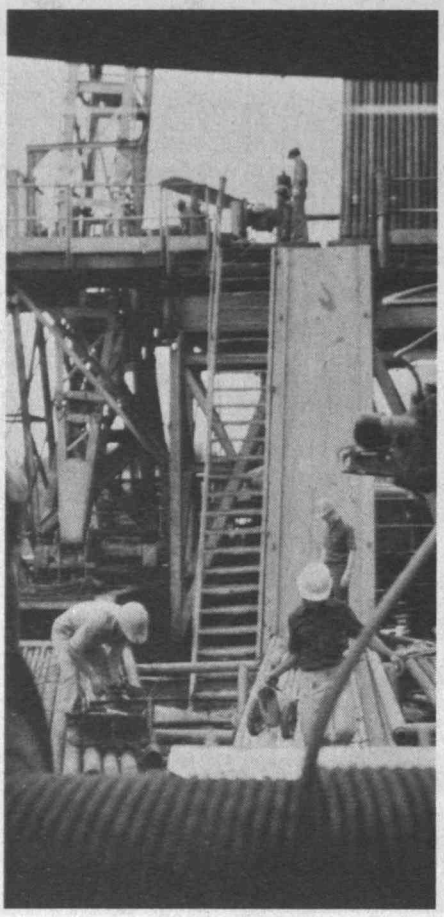
At the end of class, the instructor often has the students sit on their heels, eyes closed, and contemplate what they have learned, what the art means to them, where they are in their lives—perhaps, even, what it is to be alive and in the present with body and mind. The study of Tae Kwon Do is, for its students, woven into life's fabric.—*M.L.*

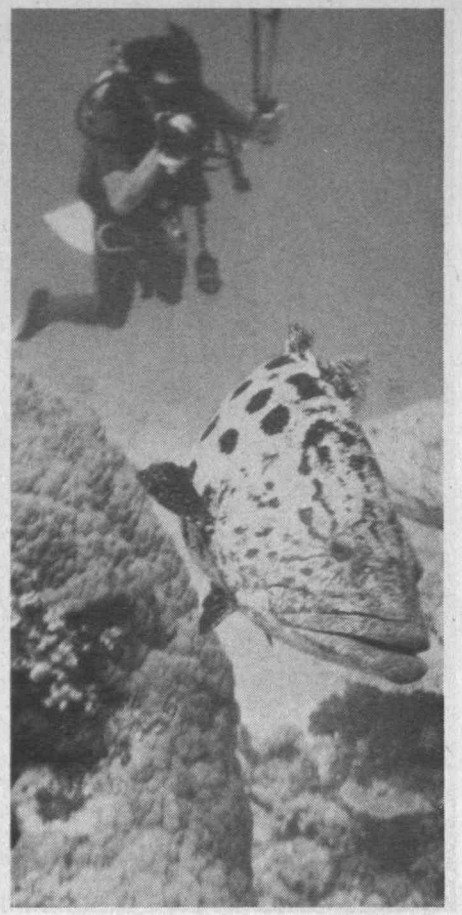


Four M.I.T. students will spend next summer in Europe, working at offices in Paris and London of Schlumberger Limited. The Schlumberger opportunity last summer was even more exciting: spend one month far afield with Schlumberger oil exploration crews, and then spend a month anywhere in the world, at Schlumberger's invitation, doing your "thing." The following account describes how one of last summer's winners spent the summer of 1981.

Four Weeks of "Everything" in Java, Then the Peace of the World's Greatest Reef

by Lawrence B. McCann, '82





Pictures of a Schlumberger-sponsored odyssey—an oil site near Mundu, Java, and "cod hole" on the Great Barrier Reef, Queensland. (Photos: Lawrence R. McCann, '82)

I hadn't realized what an opportunity I had been offered, until I was alone on a train on my way to Cirebon, a small town in Java, Indonesia. It was on that train that I finally had time to think. In the last five days, I had traveled halfway around the world from Boston to New York, Los Angeles, Honolulu, Taipei, Singapore, and Jakarta. Now I was heading toward Central Java, alone, toward the Jatibaring oil field in remote Mundu, some place called JVT, my home for the next month as engineer-trainee for Schlumberger.

I knew more about Schlumberger than most M.I.T. students, and that probably helped to get me the job offer in the first place. I knew they were a highly efficient, technologically advanced company, a "star" of the oil industry with a reputation for well-trained, independent engineers. It was a once-in-a-lifetime opportunity for me, and I am still feeling the effects.

I had spent three straight years at M.I.T. almost always studying. Even during summers, I worked for my department or a research institute in the area. When I saw Schlumberger's advertisement in *The Tech*, I was fascinated. I had never worked for industry and thought it would be an excellent experience and change of pace. So I applied, feeling I had nothing to lose and knowing Schlumberger's reputation. The interview went very well, but I was still amazed to receive that special delivery letter.

When I arrived in Mundu, I found five Schlumberger engineers living at JVT: the chief engineer, a Rhodesian, an English and a Norwegian engineer, a Canadian pre-school trainee, and a French technician. I was not only half way around the world, in the middle of nowhere; I was working with people from all over the world.

For the entire month in Indonesia I worked on Schlumberger's oil logging operations: making measurements on oil wells, drilling and cementing wells, seeing how the measuring instruments worked and how their data are used. My very first Schlumberger "job" began the night I arrived. Having traveled thousands of miles by plane, train, and car in only a few days with very little sleep, I watched with sleepy-eyed fascination as they lowered the first string of tools down a drill hole. I listened to the jargon and the three-letter acronyms for everything: log down, spikes, repeats, infiltration diameter, porosity, resistivity, spontaneous potential, microspherically focused log, etc. . . .

Over the next four weeks, I was exposed to everything from building a correct rope socket to the principles and interpretation of oil logging, with a ring job on the truck in between. Even the truck itself was unbelievable—an engineer's dream, $500,000 of sophisticated electronics including a PDP 11 computer, assembled from the ground up by Schlumberger.

Over that month, I saw much of Java by jeep, train, and plane. I spent three days calibrating instruments for a future job in Dermau, East Java, a location so remote that some of the villagers had never seen a white man. They lined up outside the truck and stared all day, running from me as I walked toward them and screaming when I first tried to photograph their gold-toothed smiles. My blond beard was a constant source of amusement and wonder.

I spent the second month in Australia, traveling and SCUBA diving the Great Barrier Reef. My instructions were simply to travel to the reef and book a dive trip; Schlumberger would pay all expenses. Because of a cancelation at the last minute, I got on a 50-foot dive boat, the *Auriga Bay*.

The reef was indescribable, the most beautiful sight I have ever seen. Fifty kilometers out at sea, with nothing in sight, suddenly breakers and emerald green water appear. Dotted by wooded, deserted islands and coral cays, the reef reaches so far north it almost touches Indonesia—the "world's largest living thing," a 2,000-kilometer ribbon of coral. Beneath was a wholly different dimension: tranquility and silence, giant clams, moray eels, sharks and seasnakes.

By September, when I headed back to Boston, I felt numb—so much had happened to me.

JAMES J. SNYDER, '80

Killian Court: Cafeteria, Playground Meeting Place, Sanctuary

by Stephanie Pollack, '82

The Institute always looks less threatening from across the river, and on this first warm night of spring Killian Court looked positively serene. I viewed the scene from a dock on the Boston side of the Charles, content to feel the large scoop of Steve's ice cream melting in my stomach and to let my mind wander. Without moving I could conjure up visions of the distant setting 12 hours hence, when the quiet would be shattered by the hurried passage of preoccupied people. That scene faded quickly, however, to be replaced by the memory of another spring when the Court's dimly-lit rows of trees were marked only by silence.

I had first viewed the court on a similarly inspirational April evening as a high school senior on a pilgrimage to my chosen place of study. Some time after midnight a group of upperclassmen volunteered to give me a tour of the Institute. Their enthusiasm faded quickly, but a small group remained behind on the damp grass of the court for an early morning gabfest. An hour or so of sitting among gray buildings, staring at the river, and listening to tales of horror and woe both relieved and reinforced my anxieties about the decision to come to M.I.T.

The choice had been made, however, and I returned to M.I.T.'s grassy oasis five months later for the freshman picnic. On my first visit, night and darkness had turned the courtyard into a cloistered patch of greenery overshadowed by towering walls bearing the names of those whose work had haunted generations of students as they made their way through the gray corridors of the Institute. But now filled with light, people, laughter, and frisbees—Killian Court acquired an entirely different character—a limited but needed haven for enjoying the outdoors of the type so often found on urban campuses.

I spent a lot of time in and around Killian Court during my first two years at M.I.T., and came to think of it as the pivot around which my life at the Institute revolved. The court was an excuse for staring out the window rather than listening to lectures. It was the perfect place to bring a book to do an assigned reading, knowing that the study session would quickly dissolve into an outdoor nap. Killian Court became my cafeteria, playground, meeting place, and sanctuary. I planned my routes through the Institute to include as hike through the court as often as I could.

Somehow, though, the frenzied pace of Institute life erased even the small amount of free time I had to devote to the court. Reading for courses took place in the library or not at all. Lunches were eaten surreptitiously during class. The planning of routes through M.I.T. became little more than finding the shortest distance between two points. I lost touch with my green haven.

Last fall, history brought me back to the court. In the course of assembling a special project on the history of M.I.T., I came across the photo collections of the M.I.T. Museum. These visual archives, neatly catalogued in rows of file cabinets, reminded me of my recent attachment to the court by illustrating the role that this setting has played in the lives of generations of Institute students. The earliest pictures, taken during construction of the Cambridge campus, showed little more than a muddy yard overcrowded with railroad tracks and piles of lumber. Another appealing set of photos showed the court filled to overflowing with uniformed Tech cadets celebrating V-E Day. Many other pictures captured students eating, sleeping, and reading, wearing the clothes and bearing the mannerisms of many decades.

Thus inspired, I rediscovered Killian Court this term. Yesterday, however, my sanctuary reminded me that the time has almost come to leave the confines of the Institute and the court. Workmen have begun to assemble the platform for commencement, and piles of timber will soon intrude on students' frisbee practice. The construction will be an inconvenience, but I am glad that I will receive my diploma in the court. I cannot imagine a more appropriate setting in which to mark the end of my four years at M.I.T.

James R. Killian, Jr., '26, describes his chance to live in Alpha Theta of Sigma Chi as "one of the memorable events" in his career; and since that happened 58 years ago, "I have been around for a substantial part of Alpha Theta's total history," he said at Sigma Chi's centennial banquet on April 17. Like thousands of other M.I.T. alumni, he said, in the fraternity he found "a mode of living and a rewarding fellowship that contributed to my social and intellectual growth." (Photo: James J. Snyder, '80)

A Century of Fraternities at M.I.T.: Fellowship, Enrichment, and a $5.6 Million Problem

Fraternities at M.I.T. are a contradiction: after 100 years during which collegiate social fraternities in the U.S. have first grown but more recently diminished in stature and repute, the M.I.T. fraternity system has grown and grows. Today it is more than simply alive and well: it is "very, very strong," says Stephen D. Immerman of the Office of the Dean of Student Affairs—"the single most effective way for M.I.T. undergraduates to learn to live with one another, to become part of something that is bigger than they are."

Alpha Theta of Sigma Chi is the flagship of this fleet; founded on March 21, 1882, it is now M.I.T.'s oldest continously operating fraternity. To celebrate its 100th anniversary Sigma Chi and the Interfraternity Conference joined on April 17 and 18 to throw a party—or rather, a series of parties: a dinner at the chapter house for members and alumni on April 16, a centennnial banquet and formal all-Institute centennial ball on April 17, and an open chapter meeting, brunch, and informal birthday celebration on April 18. A $110,000 renovation of Sigma Chi's house at 532 Beacon Street was completed only two years ago, and many of the 150 Sigma Chi alumni came not only to celebrate but to admire the restoration of the house to its proper Back Bay elegance.

At the centennial banquet, James R. Killian, Jr., '26, president emeritus, reminisced on his own years first as an active and then an alumnus of Sigma Chi. He found at Sigma Chi, he said, just what students today find in M.I.T. fraternities: "a rewarding fellowship that contributed to my social and intellectual growth . . . a sodality from which I gained new standards and an enlargement of views which came from association with talented men of varied backgrounds and outlook."

The friends he made as a member of Sigma Chi "continue to be an enriching and pleasant feature of my life," said Dr. Killian.

There are now 33 fraternity houses at M.I.T., and one-third of the undergraduates live in them. But their influence as an undergraduate housing alternative is even greater than these figures suggest, Mr. Immerman noted at the Sigma Chi open meeting during the celebration. Since some 25 percent of M.I.T.'s entering classes are women, fraternities actually accommodate nearly half of all the eligible men in every freshman class.

Though Dr. Killian was explicit on the social reasons for their choice, Mr. Immerman suggested another reason: living costs for one year at M.I.T. may be up to $500 less in a fraternity than in a dormitory.

Despite this central role in M.I.T. housing, fraternities remain truly independent of the Institute. Though Mr. Immerman's office—and through it many other Institute services—have been helpful, "every initiative undertaken by M.I.T. was first identified by a student or alumni group," Mr. Immerman said. "The success of every undergraduate chapter has been dependent on its actives and its alumni."

Perhaps the most visible form of alumni support is the Independent Residence Development Fund, organized by the Alumni Fund to provide through alumni contributions money which can be loaned at low interest to fraternities for capital improvements. In 20 years since IRDF was founded, some $6.5 million has been made available to 32 different fraternities, Mr. Immerman said; and "no house is now in default" on its IRDF repayments. But the needs are far from met. Most of the houses are old, and many have lacked the resources for proper maintenance. Identified renovation needs total some $5.6 million, far beyond the present resources of IRDF.

Another problem, too. The "lodging house" licenses which fraternities require from the city of Boston are given only with reluctance for housing in the Back Bay, an increasingly fashionable district of homes and condominiums. There is constant concern that the 20 fraternities in the Back Bay may have to leave.

BOSTON HERALD

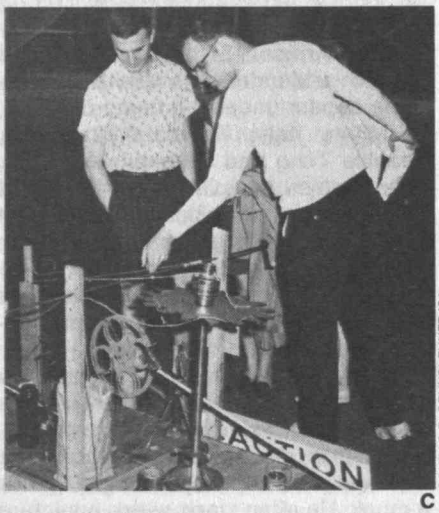
A

BOSTON HERALD

B

E

A centennial fraternity scrapbook from the files of the M.I.T. Museum: ***A—1938:*** *Theta Xi pledges graze a cow on Boston Common.* ***B—1940:*** *D.K.E. pledges fry eggs and sweep the sidewalk in a February snowstorm.* ***C—1963:*** *Phi Kappa Sigma's "nutcracker" at the I.F.C. "Olympic Games."* ***D—1920:*** *Beta Theta Pi drives a "steam roller" into Walker Memorial.* ***E—1927:*** *A retired paddy wagon serves Sigma Chi.* ***F—1963:*** *Zeta Beta Tau at the All-Tech Sing.* ***G—1964:*** *Rush Week starts at the airport.* ***H—1982:*** *The newest house is Zeta Psi at 233 Massachusetts Ave., Cambridge.*



CONRAD E. GRUNDLEHNER '64

C

CONRAD E. GRUNDLEHNER, '64

F

F. S. LINCOLN

D

OWEN D. FRANKEN, '68

G

JAMES J. SNYDER, '80

H

Hayden Gallery Displays High Fashion Clothing

An exhibition of high-fashion clothing as an art form in the Hayden Gallery? An extraordinary idea. Here is how Susan Sidlauskas, Hayden Gallery curator, explains the show titled "Intimate Architecture: Contemporary Clothing Design" which continues through June 27.

It all started a year ago with the thought of doing a small corridor show. Then things snowballed.

"I followed my instinct after I noticed a few designers and pillaged every fashion magazine to find an architectural underpinning—designers who brought the conceptual approach to the design of clothes," explains Ms. Sidlauskas. "I was looking for structure and for designs that are abstracted from anatomy and less dependent on the human form. My interest centers on clothes designers that experimented with shapes, who used the body as a framework to push the limits of form around the body.

"It was important to me that these designers were consciously grappling with the design of clothing as a discipline which required the solving of certain spatial problems," she adds. She looked for designers who were working out a consistent theme in their work. For example: some work only in black and white, some with simple geometric forms, like triangles or squares. They have been influenced by architecture and sculpture; they're trying to realize a personal vision, not just a style.

Designers represented in the show: Georgio Armani, Gianfranco Ferre and Mariuccia Mandelli (Ms. Mandelli's designs appear under the name of Krizia) of Milan, Italy; Ronaldus Shamask, Yeohlee Teng and Stephen Manniello, based in New York City; Issey Miyake of Tokyo, Japan; and Claude Montana of Paris, France. They will contribute more than 30 pieces of design art.

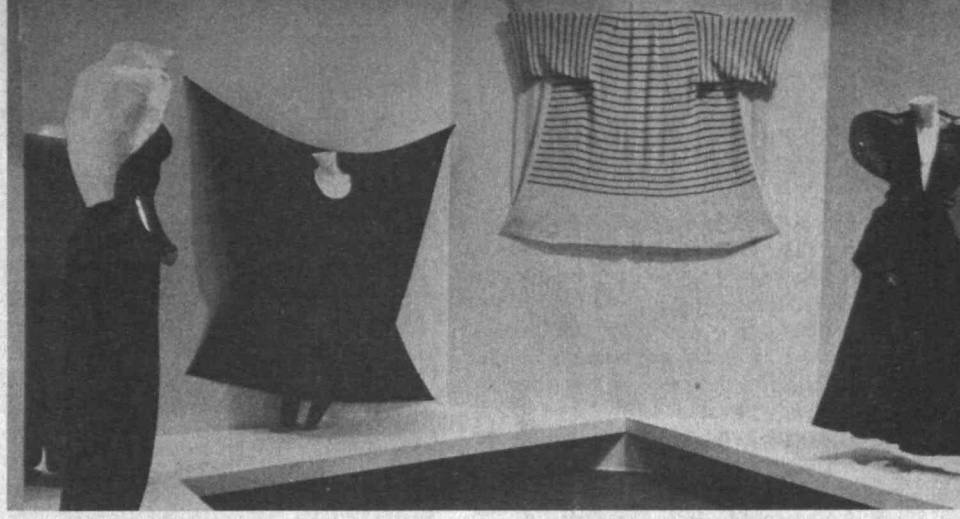
Each has a specialty. Ms. Sidlauskas explains the techniques of the designers:

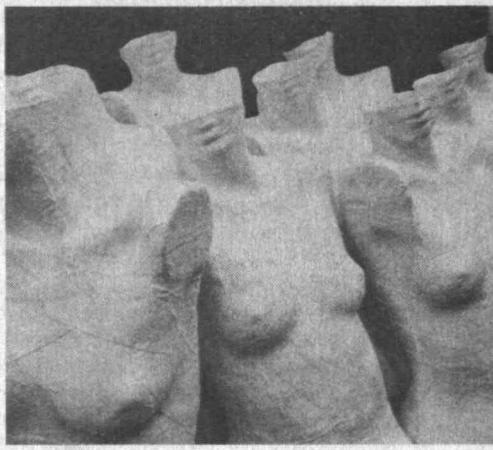
Shamask uses blue prints and graph paper to plot out his clothes. All his designs have to do with the manipulation of two dimensions into three. His three-petaled wool cape brings to mind a monk. He often starts with a miniature paper model, as an architect would. Out of this method came his famous "spiral coat" (included in the exhibition) which contains only one seam which spirals around the body. He uses plates like an architect uses columns.

Claude Montana creates hats that resemble ecclesiastical headdress. Surrealism and an interest in archaeology have given this designer his inspiration.

Georgio Armani mimes armor with his Samurai evening dress.

Gianfranco Ferre designs jackets with wide, fan-like collars, stiff white panels that look like religious or nautical uniforms.





Yeohlee Teng often works with black and white. Her juxtaposition of small shaped planes which float over larger planes tampers with spatial perceptions. For instance, a place where a pleat would recede jumps out at the viewer in white.

Steven Manniello's designs are all geometric, the forms derived from a triangle, circle or square. His materials are luxurious supple satins, cashmeres and leathers.

Issey Miyake combines east and west, with kimono shapes; he uses innovative materials such as rattan and cast plastic. His designs are vigorous and imaginative interpretations of traditional dress with various ways to tie or wrap them. He wants the wearer to influence the form.

Mariuccia Mandelli handles material like paper, using mostly solid colors. Her silhouettes abstract and flatten the contours of the body.

The designs in the show are mounted on three-dimensional white shapes that form the torso of a manikin with a neck and head that stops short above the mouth and a body ending at mid-abdomen. They are suspended at eye level by monofilament lines attached to the gallery—so that they appear to be floating in mid-air. The effect is to emphasize the forms of the clothing themselves and deemphasize the references to the human form. Daniel Pike, gallery designer, has created sculptural supports that are a compelling design in their own right.

The photographer chosen to create the catalogue for the show is Robert Mapplethorpe, the noted New York City art photographer. "His photos are known for a moody elegance which find a formal beauty in a wide variety of subject matter," says Ms. Sidlauskas. "I wanted that approach to clothing." His model is Lisa Lyons, a body builder who is often his subject. In this role her muscular body provides a sharp contrast to the typical skeletal fashion model. "His approach to the clothing was to depict the personality of the garment, serving as a foil to the usual fashion photography," says Ms. Sidlauskas.—*M.L.*

Opposite page, top: Daniel Pike, Hayden Gallery manager and designer of the installation, adjusts a gold-pleated metallic "sayoko" dress by Ronaldus Shamask; opposite page, bottom: cast plastic hat designed by Claude Montana. This page, clockwise from top left: white silk bustier and pants designed by Gianfranco Ferre; Issey Miyake's designs in Hayden Gallery; plaster torso forms, each made by hand; Issey Miyake's rattan torso; a nautically inspired leather jacket designed by Gianfranco Ferre. (Photos: James J. Snyder, '80)

Phyllis Schlafly and Karen DeCrow Debate the ERA

Kresge is filled to capacity, the crowd's energy high: Karen DeCrow and activist Phyllis Schlafly are about to debate the merits and demerits of the Equal Rights Amendment. A group of women protesters clad in wild-west-saloon-ladies style, brightly colored, sequined fancy dress, carry placards and shriek loudly. Even louder yelling in the audience admonishes them to give both speakers equal chance to be heard. Though Ms. DeCrow's views and answers often inspired appreciative applause, the audience is adament; both sides must be heard. "Throw them out," gained in frequency as the emotional pitch of the audience rose and the protesters fervor could not be quelled.

After brief presentations by Ms. DeCrow and Schlafly came the chance for the audience to ask questions. Examples:

Q.: Do you think that, without the ERA, men will continue to put down women as they always have?

A. DeCrow: I wouldn't describe sex discrimination as evil men putting down poor quivering women. I think it's a set of rules that have existed since we're born that channel men and women into two separate groups; one protects and defends the other, the other supports the first.

A. Schlafly: Most men are not putting down women. If you are associating with men who put down women, get out of that crowd. It's very unfortunate for women to think the world is against you—you can do whatever you want. I support equal pay for equal work. The biggest put-down is the women's liberation movement's denial of the role of the wife and mother in the home. The majority of women have *chosen* the role of wife and mother; they don't appreciate being treated like it's a zero, unfulfilling and oppressive; that's not the way it is in the real world.

Q.: What's the difference between discrimination on the basis of sex and discrimination on the basis of race, religion, or disability?

A.: Schlafly: It's not the same question. There is a lot more difference between a man and a woman than white and black. (Protests from the audience). Women have not been treated like blacks.

A.: DeCrow: The cause of racial stereotypes is the same as sexual stereotypes. The effect is the same—a person is judged because of membership in a particular group, and that is arbitrary, capricious, irrational, and damaging. There was once the same attitude toward blacks in sports as there is toward women in sports now. . . . I say civil rights legislation is the same whether it's based on religion, race, or sex.

Q.: Is there any justification for drafting only men?

A.: DeCrow: No.

A.: Schlafly: In the first place i'm not for the draft. But if our country is attacked, I certainly see men as the people most qualified. The justification is that young men have physical strength, they are the risk-taking group of society (audience hissing). And history tells us we are best defended by young men in battle. The armies of enemies are all men, so what reason is there to send women?

Must Academic Values Be in Jeopardy When Universities Work for Industry?

Only 3 percent of the research in U.S. universities (10 percent at M.I.T.) was sponsored by industry in 1981. But that small fraction looms large in university policymaking.

That's because increasing industrial funds are now being sought by many universities as federal budgets decline, and because—as President Paul E. Gray, '54, explained in his inaugural Congoleum Corporation Lecture during the spring at the University of New Hampshire—there is potential for serious conflict between university and industry.

The problem, President Gray explained, is "between the essential openness and public accountability of the universities, on the one hand, and the private and proprietary interests of industry, driven by the realities of competition, on the other."

It was those issues—real, potential, or imagined, and especially as they affect research in biotechnology, the newest field of industrial interest in university research—that motivated President Donald Kennedy of Stanford to summon selected academic and industrial leaders to a resort known as Pajaro Dunes, near Monterey, Calif., earlier in the spring.

Summarizing the conclusions of that meeting, which was open only to small delegations from five major universities, Dr. Gray listed these four points in his Congoleum Lecture:

☐ Colleges and universities must recognize that, in supporting university-based research, business seeks a competitive advantage. It is not a philanthropic arrangement.

☐ But even under those conditions the development of university-industry relationships need not distort academic objectives, and they must not be allowed to do so.

☐ Secrecy, in process or results, is to be avoided; full disclosure of relationships is desirable.

☐ All research results should be communicated to the public openly and freely. Only brief delays to protect intellectual property rights should be accepted.

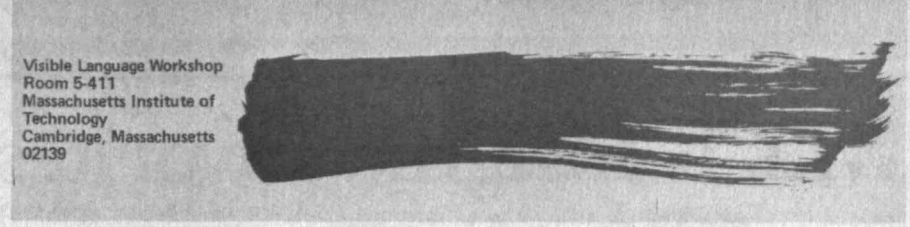
This determination to avoid secrecy in research results was accepted by all those at Pajaro Dunes—including the delegates from industry. Speaking at the end of the conference, Harvard's President Derek Bok reported to the press that "there was no dissent from anyone" that "secrecy should be ruled out" in any corporate research on campus. Indeed, President Bok said, he is "considerably more concerned about secrecy restrictions being advanced by the government" than by industry.

Indeed, Dr. Gray told his Congoleum Lecture audience, the conference reinforces his conviction that private sponsorship of university research can be arranged "on terms which satisfy business' need for a competitive advantage *and* preserve the essential openness and independence of the university."

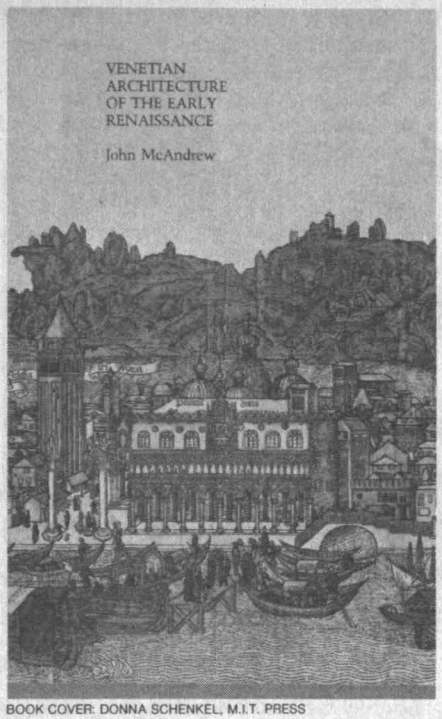
But at least three of Dr. Gray's faculty colleagues remain unconvinced. Professors John M. Buchanan and Jonathan King of the Department of Biology and David F. Noble of the Program in Science, Technology, and Society have joined the Natural Resources Defense Council in calling for an open conference on industrial exploitation of university research this summer. Their meeting, they say, will allow all affected groups to be heard on "the increasing influence of private interests over public resources, including research."

In a lecture at Stanford late this spring, Professor Noble accused the universities of "total absence of concern" about industrial control of science. "Universities have been more than willing to allow corporations to have pre-publication review . . . and have entered into many contracts in the last decade granting to private firms all sorts of rights and prerogatives they have never been willing to grant to the government," he said.

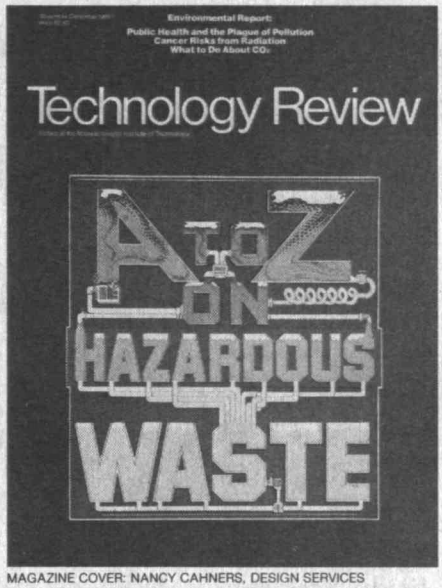
M.I.T.'s delegation to the Pajaro Dunes meeting included, in addition to Dr. Gray, Professor Francis E. Low, provost; Professor Kenneth A. Smith, '58, vice-president—research; Professor Michael L. Dertouzos, Ph.D.'64, director of the Laboratory for Computer Science; Philip A. Sharp, professor of biology; Robert A. Charpie, president of Cabot Corp.; and David I. Kosowsky, Sc.D.'55, president of Damon Corp.



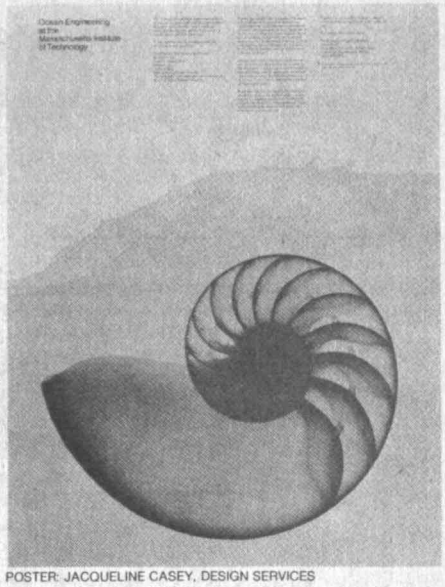
LETTERHEAD: RALPH COBURN, '47, DESIGN SERVICES



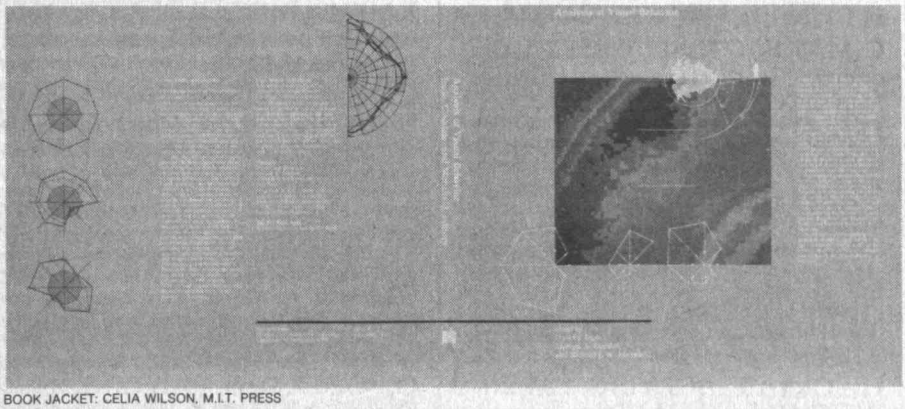
BOOK COVER: DONNA SCHENKEL, M.I.T. PRESS



MAGAZINE COVER: NANCY CAHNERS, DESIGN SERVICES



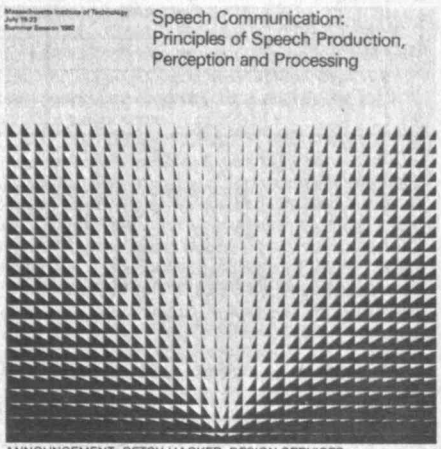
POSTER: JACQUELINE CASEY, DESIGN SERVICES



BOOK JACKET: CELIA WILSON, M.I.T. PRESS

The second Design Leadership Award of the American Institute of Graphic Arts came to M.I.T. last month for the Institute's "recognition of the cultural and communicative value of excellent graphic design to its community and audiences." Cited especially were the Design Services Office directed by Jacqueline S. Casey, the M.I.T. Press, whose design director is Sylvia Steiner, and the Visual Language Workshop in the Department of Architecture under the direction of Professor Muriel R. Cooper. The prestigious award, wrote David R. Brown, AIGA president, is a tribute to M.I.T.'s "advancement of graphic design by application of the highest standards, as a matter of policy, to all its visual communications."

DESIGN PROJECT: VISIBLE LANGUAGE WORKSHOP



ANNOUNCEMENT: BETSY HACKER, DESIGN SERVICES

M.I.T. Insignia Favorites

A Century of Service 1882–1982

A. CLASSIC M.I.T. CHAIR. Black finished northern hardwood, cherry arms, gold trim. **$150.**

B. PEWTER TANKARD. Polished finish, glass bottom. Silver raised M.I.T. veritas. Holds one pint. **$45.**

C. M.I.T. FOOTBALL JERSEY. 100% cotton, red sleeves, lettering. S-M-L-XL. **$10.** Child's, XS-S-M-L. **$7.**

D. M.I.T. BEAVER TEE SHIRT. White, scarlet trim; cotton-poly blend. Adult, S-M-L-XL. **$7.**

E–G. M.I.T. GLASSWARE. Crystal clear with platinum rim, seal. **E.** Double old-fashioned. **$2.50. F.** Single old-fashioned. **$2.25. G.** Hi-ball. **$2.25.**

H. CLEAR ACRYLIC PAPERWEIGHT. Pewter M.I.T. beaver mascot mounted inside. **$15.**

I. M.I.T. PEN SET with cast pewter veritas, grey slate base. Includes pen holder, chrome ballpoint pen. **$17.**

J. MEMO PAD HOLDER. Grey slate with cast pewter M.I.T. seal mounted on walnut. **$22.50.**

K. M.I.T. TEE SHIRT with V-neck. Grey with scarlet shoulders, trim. 50% cotton-50% polyester. S-M-L-XL. **$9.**

L. M.I.T. INSIGNIA TIE. Maroon or navy polyester woven repeat pattern. **$10.**

M. M.I.T. CERAMIC MUG. Creamy white with gold trim. 16-oz. capacity. **$9.65.**

N. M.I.T. BOOKENDS. Solid walnut with veritas. Pair **$45.**

O. CERAMIC PIGGY BANK. Creamy white, gold trim ears and hoofs. Crimson M.I.T. seal. **$9.95.**

ITEM LINE	ITEM LETTER	DESCRIPTION	QTY.	SIZE	UNIT PRICE	TOTAL
					SUBTOTAL	
					MA RESIDENTS 5% SALES TAX (No tax on apparel)	
					SHIPPING & HANDLING (See chart)	
					GRAND TOTAL	

INSIGNIA CHAIR: Freight charges collected upon delivery
ALL OTHER ITEMS:

Shipments	Within Mass	Within Other N.E. States	Within States East of Miss.	Within States West of Miss.
Up to $25.	1.50	2.00	2.50	2.75
Over $25.	free	2.50	3.00	3.50

CHARGE AND SEND TO:

NAME _____

ADDRESS _____

CITY _____ STATE/ZIP _____

☐ COOP CHG. ☐ COOP # _____

☐ MASTERCARD ☐ VISA ☐ AMERICAN EXP.

ACCT. # _____ EXP. DATE _____

SIGNATURE _____
(Required for charge orders)

☐ CHECK/M.O. I ENCLOSE $ _____

MAKE CHECK PAYABLE TO:
HARVARD COOPERATIVE SOCIETY
P.O. BOX 234
CAMBRIDGE, MA 02238-0234

FOR CREDIT CARD ORDERS ONLY
CALL TOLL FREE 1-800-343-5570
MASS. ONLY 1-800-792-5170

HARVARD COOPERATIVE SOCIETY
MIT Student Center

the Coop

Classes

13

William G. (Jack) Horsch writes, "I initiated and participated actively in a drive that achieved in 18 months a more than 50 percent reduction of our church mortgage. 'Acquired' two granddaughters-in-law recently. Thank you, Roz, for the good job you are doing for us '13ers. Hope and trust you are well healthwise." . . . **J. W. B. Ladd** writes that at age 92 he has lost the sight of one eye. He swims almost every day, has two children, seven grandchildren, and two great-grandchildren. He also goes on to say that he hopes we don't slip into another war. He was in the First World War and worked hard in the second.

We received a most interesting letter from **Charles Albert Smith**. Although he comes originally from New England stock, he has lived in the West for nearly 70 years. After earning his S.B. in mining from M.I.T., he worked in several large copper mines in Miami, Fla., and Bisbee, Ariz. He married Rose Walker in Bisbee in 1917 and moved to California (Los Angeles) in 1919. He now holds certificates in civil engineering and land surveying in California and Nevada.

In response to a letter I sent him, he says, "My activities include sitting at a desk that predates the Battle of Bunker Hill writing letters to feeders from the 'public trough' about what I believe is wrong with the government's activities (In my opinion, the world today is dangerously explosive. The communist peril is very great. Why cannot our Congress see it? Why can Europe not see it?)—doing a small amount of yard work, driving to the market about two miles away for shopping, wasting otherwise useless time watching television, holding hands with my lovely western wife, and sleeping. I am 94 years old and very much feel the physical ravages of many years of activity. My wife Rose and I have two sons and two lovely daughters-in-law. We have four granddaughters, all married, and ten great-grandchildren."

John Welch's wife Frances writes for him: "I wish I were able to give you happy news about John. He had a fall the week before Christmas and had to have a rod put in his leg. He is still in the hospital, and we are praying he will pull through this terrible experience. Other than an eye operation last July, he has done very well for his age—93. Luckly, our two daughters live quite near us, and since I don't drive anymore they see to our needs. John has kept his class *Technique*, and there is a fine picture of him and **Phil (Capen)** when they were on the Prom Committee." . . . **Julian Adler** says he has been retired for many years. He has five children, all of them teachers, and he thinks the world is a "mess."

The Alumni Office sends notice of the death of **Arthur W. Vose** on February 20 in Milton Hospital after a short illness. He was 92. Mr. Vose was a civil engineer and began his career with the Massachusetts Highway Department, working on road layout in towns in the Berkshires. He also worked on such projects as the Sumner Tunnel, the Boston subway system, and the Huntington Avenue overpass. During World War II, Mr. Vose was employed by the Bethlehem Steel Co. in Fall River, Mass. After the war, he joined the Boston engineering firm of Camp, Dresser, and McKee, and remained there until his retirement in 1968. He was an author, and in 1968 published *The White Mountains: Heroes and Hamlets*. Recently he completed a study of the Milton Cemetery, and the resulting work, *The Old Burying Ground*, is available for viewing at the Milton Library. Mr. Vose, a lifelong resident of Milton, was a town meeting and school committee member and a Boy Scout leader. He leaves three daughters, 11 grandchildren, and a great-granddaughter.

This is all for now. We'll save a few letters for next month. Happy gardening.—**Rosalind R. Capen**, Assistant Secretary and Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

14

A delightful letter from Vi and **Ted Gazarian** reports that they spent the winter as usual in their condo, with a view of ocean and pelicans, in Ormond Beach, Fla. A while back they visited their daughter in Hawaii and spent last summer in Colorado Springs, where she now lives. The dry air there agreed with them, and, in spite of the altitude, Ted went jogging every morning. They now plan to spend half the year in Colorado and half in Florida. Their children are doing well and they have a great-granddaughter.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

16

Again, no letters from classmates. However, we did make a few contacts by telephone. **Charlie McCarthy** had a very quiet winter and is looking forward to the warmer weather. He's feeling fine and said that Betty is feeling better. . . . **Henry Shepard** reports that he survived the very long, cold, and snowy winter and is hoping that the cool wind will disappear so that we can enjoy the spring. After turning 85, he noticed that he started to lose energy, and with each passing year his energy diminishes. Nevertheless, he is able to walk around the neighborhood twice daily. He says that Frances is well and they both look forward to another class gathering. . . . **George Ousler** endured most of our tough winter, but in March he and Clare went to the island of Maui in Hawaii and thoroughly enjoyed a month there. He notes that as he grows older the longer trips become a little more difficult. He is looking forward to visiting his son, who has a place on Lake Winnipesaukee, often this summer.

We caught **John Fairfield** as he was working in his garden planting peas and onions. He said the yield is of secondary importance and the real enjoyment comes from just being out in the garden and working around. He still drives his auto in the local area but probably wouldn't be able do make a class gathering in Boston.. . . . **Izzy Richmond** answered our call as he was just coming in from a long walk around the Lars Anderson estate in Brookline. He and Anne passed up a repeat of their winters in Arizona and managed very nicely at their home in Brookline. Anne anticipates another enjoyable golf season, and both of them will be happy to attend our next class function.

All of the above send their best wishes to their classmates. Keep eating, drinking, walking, breathing, everything in moderation, and yes, of course, keep writing.—**Ralph A. Fletcher**, Acting Secretary, Groton Rd., West Chelmsford, MA 01863

17

With sorrow, announcement is made of the death of **Raymond Sawtelle Stevens** on February 15 in Boston. He had been in poor health for several months but suffered only minimum discomfort. His contributions to M.I.T. and our class cannot be overemphasized. He was our class secretary for many years, and he and **Lobby Lobdell** laid a class foundation in the early days, that became the basis for the spirit, loyalty, and support that 1917 has enjoyed over the years. (*See page A20 of the May/June issue for details of Ray's professional and Institute activities.*) Ray is survived by his sons, Frank Stevens of Essex, Conn., and David Stevens of Easthampton and Mattapoisett, Mass., and his grandchildren. He will be greatly missed.

Our losses mount! With regret the death of **Walter ('Jack') Cromwell Wood**, is recorded. He died suddenly in his home in San Diego on April 16, the day after his 88th birthday. Honorary class member **Don Severance**, who was in San Diego at the time was able to visit Jack's wife Helen (3639 Charles St., San Diego, CA 92106) shortly thereafter. Jack's contributions to life were many and widespread. His loss will be felt by many men and women, country-wide, who had the benefit of his foresight and dedication.

Announcement is also made of the death of Doris (Mrs. **Bill**) **Hunter** suddenly on March 24 at Hartford, Conn.She attended almost all of our reunions and was a competent assistant secretary to Bill's class notes.

We have current information on the scholarship awards made possible by our 1917 Memorial Fund and the Aldrin Fund. Income from the Aldrin Fund was $6,800 (principal is $106,000) and was split evenly between two students in aeronautics, Richard Shapiro and Douglas Pennock. The 1917 Memorial Fund now has a principal of $222,000 with an income of $15,900. This is awarded to 11 students. The Office of Student Aid expresses appreciation and thanks for this valuable assistance.

With regret, the death of **Frank E. Peacock** is recorded at Rockford, Ill. He had retired as a consulting engineer and formerly was chief engineer at the Woodward Governor Co. Also with regret, we report the death of **Rene A. Pouchain** at Doylestown, Pa. He had been chief chemist at the Tasty Cake Co. of Philadelphia for 40 years.—**Stanley C. Dunning**, Acting Secretary, P.O. Box 218, Concord, NH 03301

18

As these notes are being written (April 10) we in the Boston area are recovering from the worst spring snow storm on record—14 inches of the white stuff with temperatures below 20 degrees F. The sun finally came out, the wind died down, and our spirits lifted.

From **John Abrams** comes a newsy letter informing us of his recent stay at the local hospital in Glendale, Calif. He celebrated his 88th birthday on February 1st. Congratulations and best wishes to you, John, from all of us. . . . Thanks to **Herb Larner** we have news of the recent meeting of the Palm Beach M.I.T. Club. The featured speaker was President Paul Gray.

We at M.I.T. are indebted to Jean (Mrs. **Malcolm) Barber** who mailed a substantial donation to the Class of 1918 in memory of her husband. I suggested to her that there were no immediate demands on the class treasury. We then worked out an arrangement to use her generous gift to help defray travel expenses for M.I.T. faculty to meet with and address M.I.T. clubs in various cities. In fact a fund has been set up for this purpose called the Max and Selma Seltzer Alumni Seminar Series Fund.

There is much activity at M.I.T., particularly in the evening, which was not true in our undergraduate days. I attended a meeting of a number of alumni and seniors at the home of Paul Gray in February. It was a give and take session, the students telling us what undergraduate life means to them and imparting their hopes and aspirations. We responded with tales of the real world. Later in February, Selma and I attended an evening lecture in Room 10-250 by Professor Lester Thurow of the Sloan School. The lecture hall was filled with students who listened attentively and then participated in a lively question and answer period.

I regret to report the deaths of **David McFarland** (December 18, 1981), **Lawrence Marshall** (February 1982), **Walter Herfurth** (November 28, 1981). **David McFarland**, 84, of 102 W. Rosedale Ave., West Chester, Pa., died in Chester County Hospital following a brief illness. He graduated with our class in chemical engineering and was a member of the Beta Theta Pi Fraternity. During World War I, he served in the Chemical Corps of the U.S. Army. He worked for Atlas Power Co. in Wilmington, Del., for 40 years, retiring in 1961. He was technical director of the explosives division of the firm and made many contributions to the development of millisecond delay blasting, a safety measure, and held a number of patents in that field, which were used throughout the industry. David held memberships in a number of social and professional societies. In addition to his wife, Helen Seltzer McFarland, he is survived by two daughters, Patricia Bowers of West Chester and Helen Gaines of Baltimore, Md.; seven grandchildren; and a brother, Julian B., of Sebastopol, Calif.

Lawrence Marshall, 86, of 116 Whitman Rd., Longmeadow, Mass., received his undergraduate degree in business education. he joined the firm of Standard Electric Time Corp., Springfield, Mass., in 1923 and retired in 1962 as its vice-president. He was past president and member of the Western Massachusetts Purchasing Agents Association and past vice-president of the National Association of Cost Accountants District 9, as well as a member of various other professional societies. For many years, he was a deacon and member of the board of trustees of the First Church of Christ Congregational. Surviving him are his wife, the former Dorothy Flemings; a son, Lawrence P., Jr., of Groton, Conn.; two daughters, Judith M. Axtell of Hampden and Elizabeth Hammond of Rutland, Vt.; a brother William B. of Needham; three sisters, Lillian Hills of Camden, Maine, Celia Jordan of West Newton, Olive Marshall of Everett; seven grandchildren and three great-grandchildren.

Agnes Guthrie (Mrs. **Walter) Herfurth** writes to say that her husband at the age of 90 was hospitalized for a fractured hip and developed pneumonia from which he did not recover. She says he enjoyed good health during his life up until the past few years. She concludes, "We had a happy life together so I have happy memories." Agnes is herself recovering from three fractured vertebrae due to a fall and reports that she is getting stronger every day.—**Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146 and **Leonard L. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

I am sure you share my pride when someone from M.I.T. hits the news, and perhaps even more so when they are from the Class of 1919. We are indebted to **Francis A. Weiskittel** for a news clipping from the *Baltimore Sun* relative to the late **Philip L. Rhodes**. Richard Henderson, a yachting writer, has written an intimate book on the work of Rhodes as one of the nation's most versatile naval architects, *Philip L. Rhodes and his Yacht Designs*. Weiskittel writes that he is feeling good and happy and enjoying his family. His son is now head of the classics department at Hobart College, Geneva, N.Y. Weiskittel and "Dusty" Rhodes lived at one time in the dormitory, Runkle Hall.

We have received a copy of a letter from the director of the M.I.T. Library to **Robert B. MacMullin** acknowledging his gift, a copy of his unpublished autobiography in three volumes, *Odyssey of a Chemical Engineer*. If the entire works is as interesting as a few excerpts read at our last reunion, we would all enjoy reading the odyssey and look forward to its early publication.

Some members of our class might have interest in the M.I.T. Sustaining Fellows program to recognize and more effectively involve those individuals whose support, encouragement, and commitment to the goals of M.I.T. make them valued members of the M.I.T. community. For more information write to E. Barbara Lewis at Room 3-231 at the Institute. With regret we record in these notes the passing on December 2, 1981 of **Phil R. Thompson**. His home was in West Yarmouth, Mass. We have no further information at this time.

By the time you read these notes you will be more aware that in less than two years some of us will be meeting at our 1984 class reunion. We hope you the reader will be one of them. The committee will soon be activated and you will hear. We hope you can make at least tentative plans. Have a good summer.—**Wilfred Langille**, Secretary, Box 144, Gladstone, NJ 07934

20

After all these years, it is good to be on the receiving end of correspondence with **Eric Etherington** of 12412 Deerbrook Lane, Los Angeles, Calif., where he has recently relocated from Lakewood, N.J. Eric has been having a lively time renewing acquaintanceships with some of his old business friends in the California power and light fields. He was a public utility specialist with Calvin Bullock. Eric writes, "I sure would like to get back for our 65th." We sure hope he makes it.

Regretfully, I have to report the deaths of two good classmates. **George I. Brown** of 1421 Henderson Dr., Kalamazoo, Mich., died on January 23. He operated his own company as an industrial management consultant. **Richard Bower** of 66 Front St., Weymouth, Mass., died on January 1. He was an engineer for WBZ television and radio for 25 years. He began his career with the Mobil Oil Co. as a shipboard radio operator and went from there to Gimbele Brothers radio station WCAE as a radio transmitter. He is survived by a brother, a sister, and ten nieces and nephews.—**Harold Busbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21

The last time your secretary wrote class notes it was a hot day in Sarasota and our southern sojourn was coming to an end. Today, April 6, it's snowing hard in northern New Jersey, and the weatherman says we may get up to a foot of snow—perhaps the heaviest snowstorm of the winter. The calendar says it isn't winter and the crocuses were blooming yesterday in my garden. C'est la vie!

Before we left Florida, Betty and I attended a luncheon meeting of the M.I.T. Club of Southwest Florida with Millie and **Herb Kaufman**. Beth and **Whittier Spaulding** also were there. It was a most interesting meeting with an excellent lunch and a fine speaker, Dr. John Nash Ott, talking on the subject, "Color and Light." Some of his demonstrations were unbelievable but convincing, showing the effects of different colors of light on man and other living things. The Haywards' final date in Sarasota before leaving March 1 was a cocktail and dinner date with Claudia and **Josh Crosby** as hosts and the **Whittier Spauldings** also attending. Claudia cooked us a delicious dinner.

Helier Rodriguez of Tampa, Fla., phoned just before we left to come home. He expressed regrets about not seeing us and said he hadn't realized we were leaving so soon. He and Graciela have both been reasonably well and quite busy since our 60th Reunion last June. I also phoned **Dick Spitz** one day and learned he was no longer working in the Sarasota Hospital but is keeping busy and enjoying sailing.

A letter form **Horace Tuttle** received in late March says in part, "Greetings for 1982—good luck, good health, and happy landings. Pearl seems to be over her sciatica—rough while it lasted. My shock seems to have let up, but I'm a little weak on my pins. Our senior citizen muscial group in which Pearl and I take small parts, has been invited to put on a variety act at the world's fair in Knoxville, Tenn. The Doc says Pearl and I would find the trip a bit too much for us, alas! However, 42 of the group may go if the cost of $600 apiece doesn't floor them. The fair does not pay amateurs anything."

Sadly we report four deaths this month: **Jerome J. Collins**, Washington, D.C. on August 28, 1981; **Richard W. Smith**, Columbia, Md. on January 6, 1982; **Sydney W. Gould**, Madison, Conn. on January 28, 1982; **Lawrence O. Buckner**, York, Pa. on February 20, 1982.

I have no information on the career of **Jerry Collins** whom I knew as an undergraduate living in the dormitories. . . . **Dick Smith** served in the Army during World War I. Besides his M.I.T. degree, he earned a master's in geology from Cornell University. Subsequent to graduation he was assistant state geologist in Tennessee and later state geologist in Georgia. In 1940 he worked for the Bureau of Mines in Alabama, and then in 1946 he moved to Washington, D.C. to manage the natural resources department of the Chamber of Commerce. Dick was a prolific writer, publishing numerous papers in professional journals.

Sydney Gould was a 1919 graduate of West Point and then came to M.I.T. to get a degree in civil engineering. He served in both world wars, attaining the rank of colonel in World War II. He retired in 1951 as vice-president of Lomas and Nettleton Co. of New Haven. Gould received a National Science Foundation grant for his work in botany and became associated with the Connecticut Agricultural Station in New Haven. He was the author of three books on botanical subjects.

Lawrence Buckner died following surgery at the York, Pa. hospital. He worked for the Metropolitan Edison Co. for 33 years and retired in 1963 as Western Division sales manager. After retirement he served as a consulting engineer for McCrory Corp. for eight years. He was an Army veteran of World War I. Buck attended our 50th Reunion in 1971 and was responsible for taking fine snapshots of many of the couples attending.

The sympathy of the class is extended to the families of these men.—**Sumner Hayward**, Secretary, 224 Richard Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

22

Your secretary enjoyed missing the cold weather of the Northeastern states this year. March in the South was glorious—as was January and February. April in Buffalo was okay until THE STORM.

Parke Appel had health problems in February and was operated on but is healing very fast. At last report he was working hard on our Reunion plans. He was also working on the Course VI Centennial scheduled for October 2-3. The Class sends best wishes for his speedy recovery. . . . **Yardley Chittick** writes of eight perfect days in Bermuda while hoping for the same at our June reunion. . . . **Roy Stone** sends greetings from Clearwater, Fla. . . . **Marjorie Pierce** of Weston, Mass., wrote that she was looking forward to seeing your secretary and classmates at the 60th. Marjorie took the *Flying Cloud* cruise to the Leeward and Windward Islands in January. Very posh cruise but not as much sailing as she would have liked. Marjorie is keeping busy with her clients and giving talks at Rotary and other local clubs.

A short note from **Charles C. Bray**, 4322 Prospect Ave., Western Springs, IL 60558, says he attended high school with Julia Avery, '18 at Framingham Academy and High School. Charles entered Tech in the fall of 1916 and was with the first freshman class in the new building on the river. He reminisces about a large tent collapsing in June 1922 when getting diplomas. . . . **Theodore P. Shilkoff**, Route 1, Warrenton Shores, Guntersville, AL 35976, turned 93 last May 29. He writes: "Unfortunately I am living in a chair here in the deep South because my legs have given up the ghost." An invitation is extended to the class to come by for a visit if ever in the area. . . . It's nice to hear from **Sam Reynolds**, 2150 Mar East St., Tiburon, CA 94920. At the time of writing, he was planning to be with us at the reunion. . . . **Frank Kurtz**, who still resides at 734 W. 9th St., Delray Beach, FL 33443, recently attended the Palm Beach M.I.T. Club. **Frank Reiger** also attended. Frank K. plans several trips, including one to New York for his grandson's wedding and another to California for a second grandson's wedding. Frank is feeling fine and is as busy as can be. . . . We received word from Edith (Mrs. **William G.) Rapp**, 16 North Chatsworth Ave., Larchmont, NY 10538, that Bill passed away on January 10. He was active and energetic to the last day. You may be interested to know he sent a vast collection of his photos and files to the M.I.T. Rotch Library (Includes 900 slides on construction use). Bill's material is listed in the Institute Archives and Special Collections of the library. Edith sends her best regards to the class. Bill will be missed by all. . . . We have received a newsclip about the death in October 1981 of Dr. **Walter Willard Boyd**, a retired obstetrician and gynecologist, and a photographer and collector of rare books. Dr. Boyd is survived by his wife Ruth, a son, and a daughter. . . . We also regret to inform you of the passing of the following members of our class: **Daniel A. Brown, Jr.**, P.O. Box 193, Pocasset, MA 02559; **Anders V. Johnson**, 85 Williams St., Malden, MA 02148; **Wallace H. Dibble**, 17 Highland Rd., Bristol, RI 02809; **Lloyd A. Elmer**, 130 Pine Grove Ave., Summit, NJ 07901. The sympathy of our class is extended to all of the families.—**Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, FL 33060

23

Norman Weiss reports that on August 15 he will publish *Memoirs of a Millman*, covering his career as a metallurgist in Latin America to 1947, and that a second volume will come later. A descriptive flier can be obtained by writing Norman at 2620 N. Norris Ave., Tucson, AZ 85719. . . . **Lawrence Barstow** writes that he retired from Burroughs Manufacturing Co. in 1972 and now is a member of the Kalamazoo Area Transportation Executive Committee. . . . **Michael Drazen** writes that he still is active in his firm specializing in economics of use of electricity and gas by industry; that his son Mark, '69, is a member of the firm, and that his son Allan, '72, is teaching at the University of Chicago. . . . **Gerald Fitzgerald** (our assistant secretary) says that he still has an office at the University of Massachusetts (Amherst), which he uses frequently. . . . **Lockwood Oliver** says that he can now boast of having four great-grandchildren and hopes that some of them will attend M.I.T. . . . **Stanley Setchell** writes that he retired in 1975 after many years of pleasant practice of architecture, in which he was primarily a project manager and job captain of large undertakings.

Columbus Lord died January 15, 1982. He graduated with our class in architecture, having previously studied electrical engineering at the University of Maine. During World War I he served in the U.S. Army Signal Corps. After being employed as an architect by firms in Boston and Philadelphia, and with the departments of the Treasury and the Army in Washington, he became an engineer with the City of Boston. Later he returned to Washington for work with the departments of the Army and the Air Force, and finally after 16 years with the Office of the Secretary of Defense in Washington, he retired and engaged in private practice as a consultant on military air facilities. He was a member of the American Institute of Architects, American Society of Civil Engineers, National Society of Professional Engineers, Highway Research Board, National Research Council, National Academy of Sciences, Virginia Academy of Science, Aero Club of Washington, and National Aeronautics Association. His hobbies were photography, flying and contract bridge.

John Ogg died January 19, 1982. He graduated with our class in architecture, having previously studied at the University of Columbia School of Architecture and having been a teacher and athletic coach at high schools in North Dakota and Arizona. He became a specialist in socio-recreational architecture and served on the field staff of the National YMCA Building and Furnishings Service, 1923-35, spent a year with the Housing Division, PWA, and returned to the field staff of the National YMCA, 1936-41. In 1941 he became associate director of USO Building Service and was director from 1945 until 1960, when he became volunteer architectural consultant on overseas YMCA buildings for the International Committees of YMCAs of the U.S. and Canada. During his tenure he worked on more than 500 YMCA projects and 1800 USO recreation clubs and centers in 32 foreign countries.

Benjamin Powell died November 10, 1981. He graduated with our class in civil engineering, having previously studied at Colorado State College. He had an extensive career as a construction engineer. He was chief engineer of the Liberian Boundary Commission in 1927; district engineer in Jeremie, Haiti, in 1929; assistant chief engineer for a steel fabricating company in Denver in 1930; and for eight years, beginning in 1933, in charge of dam building in Oklahoma for the Department of Agriculture. During World War II he was chief of the design section of the Corps of Engineers, Denver Office, and in 1945 took over the job of area engineer, U.S. Bureau of Reclamation, in Pueblo, Colo., where he completed the report on the Gunnison-Arkansas Trans-Mountain Diversion. In 1954 he grubstaked a group to a uranium mine in Colorado that became profitable, and he retired in 1956 to a ranch near Los Lunas, N.M.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

25

The May/June class notes informed you that Joe Martori had been asked to become an honorary member of the Class of 1925. Joe has responded as follows: "It is with extreme pleasure that I accept honarary membership into this 'Great Class of 1925.' It certainly will be an honor to wear my 1925 red jecket to M.I.T. functions, and to be associated with such an august group." Also, he noted that first "official wearing" of the red jacket was to be at the Mexican Fiesta.

Your secretary has just returned (April 1) from a six-week automobile tour of Florida, spending two weeks at Plantation Key, but visiting many friends and relatives at various cities and taking the opportunity to see several classmates. Evelyn and I were entertained in Boynton Beach by Janice and Leo Dee, '35. While there **Charlie Allen** was reached by phone in Lake Worth. Charlie retired as president of the Allen Chair Corporation in West Concord, Mass., in 1956. At that time he had been serving the Town of Concord as a selectman. He enjoys living in Florida, participates in the activities of the West Palm Beach M.I.T. Club and comes north on few occasions. We got together with Adele and **Ed Kussmaul** in their mobile home in Briny Breezes. Ed is making oil paintings, copying some of the old paintings of the masters. He is quite successful with this hobby. A stop in Naples gave us the opportunity to visit for several hours and have lunch with Eleanor and **Fred Greer** in their fine condominium. We did a lot of reminiscing and enjoyed every minute of it. It appeared, at first, contact with **Franklin Fricker** would not materialize, but after being away for several days he arrived back and we had an hour-long chat at our motel room. Franklin is doing well and keeping quite busy. After several stops we arrived in Atlanta and were treated to real Southern hospitality at the home of Mildred Hitch, where her son-in-law **Ben Oxnard** resides. Ben was with the Great Western Sugar Company and decided upon retirement to forget the sugar industry. He set about learning book-binding and bound several books dealing with the history of the sugar industry. He still has a considerable interest in sugar and attends conferences quite regularly. Ben has many interesting stories about persons he met during his career, and he is a great entertainer with his stories. Ben arranged for us to see many of the interesting areas in Atlanta. On arriving in Atlanta we found there was a meeting of the M.I.T. Club scheduled for that evening with M.I.T.'s treasurer, Glenn Strehle, '58, as the speaker. The meeting was held at the spacious home of Dr. Thomas S. Rowe, '62, and a pot-luck supper was enjoyed before the meeting.

While in the Keys we visited the Lignumvitae Key, a Florida State Park of about 250 acres reached only by boat. We were in a group of about 25 people on our tour and discovered in this small number a couple from Duxbury, Mass., who knew **Arch Nickerson** as a member of their church. When I returned home I found a note from Arch saying that his consulting assignments are few and modest. He expressed his gratefulness for an astonishing interest in antique clocks, which he has been restoring since age 13. He has taught a grandson the rudiments of the trade, and he now has a flourishing clock shop.

Classmates who attended some of our recent reunions have fond memories of **George Washington's** wife Ruby. I am sorry to have to report that Ruby died in February, and a funeral service for her took place in Washington, D.C., on February 18, 1982. Ruby had graduated from Roger Williams University, Nashville, in 1922 and later received a master's degree from Columbia University and pursued graduate studies at Smith College and Catholic University. She taught mathematics to high school and junior college students for 31 years. To her professional life, Ruby brought cheerfulness and dedication, keen mind and interest in each student's maximum development. Those of us who had the pleasure of meeting Ruby can attest to this statement. I am sure that all classmates join me in expressing our sympathy to George and her brother **James C. Evans**, also a classmate.

Word has reached us of the passing of **Harry G. Olson** in October of 1981 at Bellaire Bluffs, Fla.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd, P.O. Box 331, North Chatham, MA 02650

26

It is April 6, five days before Easter, as we type these notes while the snow swirls around our win-

dows, four inches already fallen. Yesterday we had planned on a game of golf which now appears to be another week away. So goes it in our New England clime.

We have just received a note from **Don Cunningham** describing a recent trip with the annual M.I.T. Club of Mexico tour: "This is the 34th year and was at Yucatan where we heard and saw another world which existed thousands of years before Columbus. Mary and I enjoyed our second trip, but Julius Goldberg, '26, got an 'Eager Beaver' award for coming his fourth time with Sylvia. These notices don't go out to all alumni, but **Charlie McHugh** heard about it for the first time at our 55th, so he went to add to his worldly travels. Those who might like to experience one of these annual March trips should request the Alumni Office to put them on the mailing list. There were 85 from U.S. and about 25 from Mexico on the trip." We heartily concur in Don's judgment since Evelyn and I have enjoyed Winter vacations for most of the last 15 years in various parts of that country and others of Latin America, which are so important to us today.

Jim Crawford writes, "41 years with Bell of Penn. from lineman to chief engineer. Interesting assignments in operations, public relations, advertising (a wonderland), and personnel (a real challenge). Retired 1968, married 1977. Consultant to friends and family on assorted technical subjects. Usual fee: a ham sandwich lunch, which is all the market will bear. Stopped jogging since marriage." . . . A note from **Henry Jones**: "Trustee and past chairman of County College since 1964. Member of Blue Cross Board of S.E. Penna. and past vice-chairman. Family Service of Plula, past chairman." . . . Our mention of **Cesar Canals'** inquiry as to a possible copy of the 1926 *Technique* brought forth a very kind note from **Bob Richardson's** widow Margaret, from which I quote: "When Bob died, and I was clearing out a few years later, I wrote George Smith and asked if there would be any interest in Bob's four volumes of *Technique*. He enthusiastically answered, 'Yes, please send to the newly setup historical department of the M.I.T. Alumni Association.' Many thanks to you Margaret—I have sent your letter to Cesar and hope that you will have fulfilled a wish of one of our classmates.

Two of our classmates continue to receive awards for their distinguished contributions to science: **Stark Draper** was elected a fellow of the Society of Automotive Engineers, and **Peter Bellaschi** received the 1982 William M. Habirshaw Award "for contributions in the field of transmission and distribution of electric power and to the development of extra-high voltage apparatus and systems."

A newspaper announcement reported the death on January 21 of **Francis R. van Buren** of Harwichport, Mass. He was born in Nice, France, and came to Cape Cod with his family as a summer resident in 1910, and after World War II as a permanent resident. He was a major in Army Medical Administrative Corps for three years in the European Theater, returning to become the administrator of Cape Cod Hospital. He is survived by his wife Edith (Pardee), two daughters, a son, six grandchildren, and one brother. . . . Another article in the St. Albans, Vt., paper tells of the recent passing of **Charles Rich** and reports the high praise of his civic duties as city alderman from the present mayor and the current city manager. Only a few days before his death he had talked about leaving for a vacation.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

27

When these notes are read, our 55th Reunion will be history—and we trust everyone will have had an enjoyable time. Many thanks go to **Ray Hibbert** and his committee for arranging the festivities, and particular thanks to Frances Bangs of the Alumni Association as reunion coordinator for all the classes.

For the benefit of those who didn't make the reunion, we tabulate some statistics presented by your secretary:

Total Living Classmates—355

Approximate percentage of original—45 percent

Geographical location as of 1980—Eastern Mass., 60; Rest of New England, 71; N.J., 21; N.Y., 35; Pa.-Va., 35; N.C.-Ga., 10; Fla., 30; South Midwest, 18; Midwest, 20; Texas-Ar., 12; Calif.-Ore.-Wash., 33; Foreign, 17; Unknown, 40.

How many of us remember Doc Miller and took the steam and heat engineering course that required attending the coal-fired boilers at the soap factory in Cambridge? Remember also his urgent admonition to stop burning petroleum because the world supply of oil would be exhausted in 10 years? This month's notes are devoted to our living classmates whose lives were spent to proving Doc Miller was wrong:

Edgar D. Cahill, St. Louis: 17 years as geologist with Skelly Oil Co., Tulsa, withstanding the dirty work of discovering oil in the mid-continent area; 14 years as consulting geologist in Illinois, Indiana, and Kentucky. . . . **Donald L. Campbell**, Short Hills, N.J.: 40 years with Esso Research and Engineering Co. in refining and process engineering; retired as assistant to the vice-president. . . . **Robert S. Hatch**, Myrtle Beach, S.C.: 20 years with Texas Co., leaving as manager, purchasing department, N.Y.; 18 years with Arabian American Oil Co., manager, manufacturing and sales; became executive vice-president and director, Aramco Overseas Co. at the Hague; before retiring in 1965, he was vice-president and director, Aramco-Dhahran in Saudi Arabia. . . . **Erik Hofman**, Reservoir Nursing Home, Waltham, Mass.: managerial officer for various divisions of Standard Oil Co. (N.Y., Esso SAPA Buenos Aires, Esso Mexicana, Mexico City) until retirement in 1964 when he moved to Mallorca. After traveling extensively, he fell victim to Parkinson's desease in 1977. A recent report says he is partially ambulatory and would like to hear from friends. . . . **William Kaplan**, San Diego: 14 years with Cities Service Co., becoming assistant to chief engineer; 30 years with Amoco Oil in research and development at refinery in Texas City, becoming an authority on lead-free gasoline and vocal champion for its use to reduce pollution. . . . **Howard W. Page**, Mamaroneck: life-time distinguished career with Exxon refineries in Texas, New Jersey, France and England; by 1939 was assistant head of European refining; 1942-46, Petroleum Administration, Washington; 1947-49, executive assistant to president; 1949-1955 in London, director, Esso Petroleum Ltd. and Iraq Petroleum; 1954, elected to board of directors for Middle East; 1966, executive vice-president and member executive committee; devoted many years on negotiating teams with Iraq, Iran and OPEC even after retirement in 1970. He has been chairman of the trustees of American University of Beirut since 1976.

Harold W. (Bud) Fisher, Duxbury, Mass., our class president, has contributed more than any other to the petroleum industry. Started at Baton Rouge labs of Esso with his first assignment to produce oil from coal; successive assignments in research, sales and chemical products; elected director of Esso in 1945 and 1947 president of Enjay Co., the U.S. marketing affiliate for chemical products, in 1947; moved to London as Exxon's representative to the United Kingdom in 1954 and became involved in Middle East activities; joint managing director of Iraq Petroleum and associated companies, 1957-59; returned to N.Y. in 1959 to become director and after 3 years vice-president of Exxon until retirement in 1969. During those 10 years at Exxon he was responsible for petrochemicals, refining, and research and development.

These impressive records of achievements over the 40-to-50-year period have mitigated the dire prediction of Doc Miller, but to his credit his warning will come true some day—maybe 100 years later. By then we expect more M.I.T. men and women will have captured solar, geothermal, and nuclear fission energy. To help solve our present predicament, I favor: $2.00/barrel import duty on oil; $5.00 export duty on oil to Japan; $.05/gallon increased tax on gasoline and diesel for all vehicles.

We must report the death of Prof. **Lloyd A. Bingham** on January 30, 1982, in DeLand, Fla. He taught electrical engineering at the universities of Nebraska and Colorado for 40 years. He retired in 1968 and spent the summers in South Hero, Vt. We express our condolences to his widow and family.—**Joseph C. Burley**, Secretary, 5 Hutchinson St., Milton, MA 02186

28

It is quite possible that by now you will have received from **Jim Donovan** the president's letter with its enclosed printout of the current class member list and present addresses. We hope this list will enable many of you to reestablish contact with old acquaintances and to renew your friendships in time for our big 55th Reunion (now only a matter of months away!).

In a letter to Jim, **Gerry MacGillivray** reports that he has been corresponding with **Clint Perkins** (still on technical matters!). Gerry enclosed a photograph and biographical outline of his son, Kenneth, who is with the Naval Air Forces Atlantic Fleet staff. With Captain Kenneth's outstanding accomplishments and his fine appearance, Gerry has every reason to be proud. . . . A letter from **Bill Bendz** says that he and Marjorie have every intention of being at the 55th next June. As many of you may know, Bill and Marjorie moved recently from their home in Los Altos, Calif., to Cumberland Foreside, Me. Now both homes, summer and winter, are in Maine and not far apart. . . . We are very pleased to have a note from Marjorie (Mrs. **John A.) Carvalho**. She always reads the Class Notes and would like to locate some of the classmates she and John know in past years. . . . **Jim Rae** says that he is still leading the quiet retired life on the New Jersey coast. . . . **Al Daytz** expects to be at the 55th. His wife, Dorothy, died last year so Al hopes to bring his sister, Molly, to the reunion.

With deep regret we must report the deaths of five classmates. **Harry F. Cade, Jr.**, died September 18, 1978. His death occurred while he was away from home and visiting with his daughter. The information was provided by his wife, Nettie. Harry was in Course VII, biology. Following M.I.T. he attended Boston University (B.S. in education) and Harvard Graduate School. His professional life was in the field of education. He was headmaster at Berkeley Preparatory School, Boston, until 1942; served in the U.S. Navy from 1943 to 1947; then taught at Ft. Lauderdale High School for several years. In later years he held education-related positions in the military services. . . . **Francis Gerard Lake** died May 29, 1981. The notice was received from the executor of his estate, and we have no further information at this time. . . . **John C. Leslie** died January 19, 1982. John joined our class in his junior year after having graduated from Princeton University. He gradauted with us in Course XVI, aeronautical engineering, then earned his S.M. (as a Sloan Fellow) in business and engineering administration. Nearly all of his professional career was with Pan American Airways, mostly in various management positions. He played an important part in bringing commercial air travel to its present level of attainment. Besides his wife, Jean, John leaves two daughters, two sons, and 16 grandchildren. . . . **Frank L. McGuane** died October 18, 1981. Frank graduated in Course XV, business and engineering administration. His professional career was with the New York Telephone Co. For 39 years he was also associated with the U.S. Army, where he was a colonel in the Chemical Corps and commanding officer of the 464th Chemical Group. His recent activities included serving as minister prefect, Third Order of St. Francis; working with Retired Seniors' Volunteer Program; and teaching natural history. Frank and wife, Dorothy, had two sons and three daughters. . . . **Norman C. Parsons** died January 22, 1982. His wife, Kathryn, thoughtfully provided us with a copy of the obituary notice. Norm graduated in Course I, civil engineering, and held engineering positions in the New York State Highway Department and State Department of Transportation during most of his professional life.

He was a founder, then treasurer for many years, of the New York Highway Engineers' Federal Credit Union. Church and Masonic activities were among his other interests. The Parsons have a son, a daughter, and three grandchildren. We extend our heartfelt sympathy to the families of these classmates.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29

Arthur Bearse of Charlotte Harbor, Fla., and his friend, **Putnam Cilley**, have been attending Technology Day together for many years, including some of our major reunions. Arthur has sent me a note stating that "Put" has been hospitalized for an angina attack recently, and he himself has had an open-heart surgery last summer with slow recovery process, which cast a shadow of a doubt that they will be attending Technology Day 1982. Without them, it won't be the same. . . . **James C. Reddig** of Webster, N.Y. has sent me a note saying, "1981 has been a rewarding year for my chief activity of chasing airplanes. In April, I attended an Aerospace Education conference in San Antonio, Tex. via an AF C-130 and had a chance again to hear and meet Jimmy Doolittle and **"Chuck" Yeager** (who first broke through the sound barrier). In May, I went to California and attended the 50th anniversary of the founding of the American Institute of Aeronautics and Astronautics, and I was one of the 14 surviving founders gathered for the occasion. This also gave me an opportunity again for a couple of hours of flying in one of my early designs, the Fleetwings 'Seabird,' all stainless steel amphibian built in 1936, one of two still flying. A few days later, I joined a group from the National Air and Space Museum in a wonderful tour of aircraft museums and collections and flying displays culminating in two days at the Paris Air Show. Because of our Smithsonian connections, we met the curators, historians, and directors everywhere we went—all doors were opened to us. We met with the Royal Aeronautical Society, having lunch at the Royal Aero club. A grand trip and a great welcome everywhere. I am now spending some time at the Smithsonian Space Museum archives trying to help in their records of early days with which I was once connected."

Hunter Rouse of Sun City, Ariz., writes, "Thanks once again for your timely greeting! Yes, I continue to teach a graduate course in fluid mechanics at Fort Collins every summer (first time in 1940). This summer, we will be celebrating our 50th wedding anniversary at Estes Park, we hope with all our children and grandchildren. Best wishes to all from Doi and me."

Florence, **Ted Malmstrom**'s wife, of Honolulu, Hawaii, writes, "Ted still perking—walking not too good, but manages. He had his 75th birthday. We had a wonderful visit with our daughter Polly, two grandsons, and son-in-law here in June and July. Hoping to visit them in Reston, Vir., in later part of April or first part of May. Our granddaughter, Iamela, has received an appointment to West Point. We all are very proud of her. She graduates from high school in June. We enjoy living in Hawaii. We had a rainy winter but no snow to shovel. Ted's hobbies: bikini-watching at Waikiki Beach, and Florence, golf and needlepoint. Best wishes to all." . . . **Harold M. Weddle** of San Diego, Calif., writes, "I walk three miles every day and 'bowling on the Green.' Both of these are great if you have mastered golf or it has become frustrating. This 1982 is the year of our 50th wedding anniversary. Rather than celebrate the event on June 22, we are going to do it all through the year. The first was the week of January 17, when both of our sons were here visiting us. This was the first time the four of us had together since 1960. This does not imply that we do not enjoy our two lovely daughters-in-law and the grandchildren, whose visit will be another event later on in the year." . . . **Raymond Underwood** of Saunderton, Pa. writes, "I have just become 75 years old, and still have my patent law office in a local business building. I get a lot of pleasure out of getting patents for inventors and watch what new ideas and products keep coming up, which keep me busy."—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

As previously reported in the Notes, **Ken Bucklin** retired from RCA, Harrison, N.J., in 1968 as manager of receiving tube engineering and manager of commercial engineering. Since then the Bucklins have lived in Ormond Beach, Fla., where Ken is active in the Kiwanis Club as director, editor of the newsletter, and past secretary. Ken has retained his interest in ham radio with the call letters K4LP and is chairman of the Halifax Chapter of Quarter Century Wireless Assoc. . . . **J. Palmer Boggs** is professor emeritus of architecture from the University of Arkansas. He has continued a limited practice as a consulting structural engineer and does some lecturing on this subject. . . . As previously reported, **George Brady** retired some years ago as owner and operator of the Brady Air Conditioning Co. in Austin, Tex., where the Bradys still live. He apparently has given up his former hobby of raising and training English pointers, but still enjoys bird hunting. . . . **Al Burling** reports that he and Grace gave up their Nashua, N.H., home about two years ago and are now based in W. Barnstable, Mass., on the Cape. They are in "comparatively good health," which I guess is about all that members of the class of '30 should now reasonably expect. Al belongs to the M.I.T. Club of Cape Cod, which is very active. He sees **Ed Prichard** at club meetings quite often. . . . **Theodore Criley** is the senior member of the architectural firm of Criley & McDowell, which is located in Claremont, Calif., and designs and supervises the construction of school and college buildings, churches, and public buildings. As of the first of this year, he has become semi-retired. His memberships include the Church Architecture Guild of America and Southern California chapter of A.I.A., of which he is a past director. . . . We have at hand a bubbly note from **Louise Dingwell**, who is one of our "irregular" but nonetheless loyal classmates. Louise graduated from Wheaton with the class of '24, did graduate work at Johns Hopkins in '25 and at M.I.T. in '30 (Course VII), and maintains her affiliation with, and contributes to, all three institutions. Her note was largely devoted to a rapturous description of a joint M.I.T.-Johns Hopkins trip to Scotland that she took in August '81.

Supplementing the item last month about **Byron Mackusick**'s death, the letter I received from **Bill Waite** about Byron also recounted some hi-jinks that occurred in the summer of '28 at the chemical warfare boot camp at Edgewood Arsenal, Md., attended by 22 of our R.O.T.C. classmates. Those involved included, in addition to Bill and Byron, **Hijo Marean**, **Frank Fahnestock**, **Alan Vint** and **Fred Holt**. It appears that at that time the four-inch chemical mortars and ammunition carts were dragged by mules who often exhibited the traditional mule-like behavior. Confronted with this problem, Hijo invented a rather ingenious technique for dealing with the situation. According to Bill, Hijo "battled one of these mules for probably half-an-hour before he came up with the perfect solution. He got something that either was a real sword or looked like one. One jab in the butt and the mule really took off. After two or three of these episodes, all Hijo had to do was stand behind the mule and no more trouble."

Via a note from **Reg Bisson**, we have learned that **Marsh Cleary** died on October 27, 1981, after a long illness. He had suffered from emphysema for a period of over four years and was on oxygen for the latter part of this period. According to the information I have at hand, Marsh was senior construction engineer for Anheuser-Busch in St. Louis prior to his retirement in 1971. His principal hobby was paddlewheel boats. He was a charter member of the American Sternwheeler Association and at one time owned and operated a paddlewheel houseboat, as well as working as a design consultant in this field. Marsh was a class secretary's delight; he always responded to my requests for information, usually with amusing bits of information about the five Cleary daughters and his plans for them. They must be a quite remarkable group of young ladies. In his last report (obviously incomplete) they had produced 10.3 grandchildren. I shall miss Marsh's responses.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

31

Recently, while trying to raise **Fred Elser** on my ham radio, I was very pleasantly surprised to have another classmate, **John Hollywood**, W1SK, call me and ask for the address of another member of our class. Hopefully, John will join Fred and me (AA4AS) on our weekly schedules on Sunday evening at around 7:00 p.m. (EST) on 21010 kHz. I believe that it was the first time I've talked with John on the ham radio since I moved to Florida from Connecticut. . . . Thanks to the Alumni Association, word from **Parker S. Dunn** states, "Since my retirement in 1975, my wife and I have traveled and I have continued to consult for Kerr McGee Chemical Corp. on a part-time basis. Fortunately, our health has been good." . . . A welcome letter from **Fred Nordsiek** advises me as follows: "The book on our 50th Reunion was a pleasure, although I was puzzled that I did not have the opportunity to be in it, as I never received the biographical form. However, I see numerous other members of '31 are in the same boat, conspicuously absent from the volume." (Secretary's note: This complaint has been received a number of times, and I am at a loss to account for this "slip up." To the best of our knowledge, the forms and information were sent to all classmates whose current addresses were known.) Fred's letter continues: "The volume did one very pleasant thing for me, told me that **John A. Parker** is here. I never knew Jack in Tech days; as you recall, the Course IV men were always over across the river. Now I've seen Jack and his delightful wife, Jane. He's professor emeritus (I continue as adjunct professor until 1984 at least). Jack really has it made in this university town (Chapel Hill, N.C.). His distinquished academic career includes founding a department and running it for almost 30 years. He and Jane live in a delightful house in the heart of the old section of town, with an extraordinary hidden interior garden. One of his sons is an outstanding physician and professor in the medical school here." Fred's address is 500 Umstead Dr., 308 B, Chapel Hill, NC 27514.

Another omission from the reunion volume is **Standish Deake**, Course VII, my life-long friend whom I knew long before we went to Tech. He and his lovely wife, Gen, retired to an antique house in North Pomfret, Vt., they have long owned. When the rigors of winter force them off their hilltop, they retreat either to Yugoslavia or to nearby Woodstock, Vt. Many thanks to you, Ben and John, for keeping the '31 news active.

It is with sadness that we report the death of our classmate **Harold E. Searles** on December 8, 1981.

By the time you read these notes, which are being typed early in April, Helen and I will have visited Taipan, Hong Kong, and China. Probably more on this later.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben W. Steverman**, Assistant Secretary, 8 Pawtucket Rd., Plymouth, MA 02360

32

These notes are being written in April. You will read them in July, and our 50th Reunion will be among our pleasant memories. This is a good time to say that our chairman **Ed Nealand** stayed on top of everything to insure a smooth-running reunion. The committee attended several meetings and diligently carried out their assignments. **Robert Lemple** and his gift committee functioned smoothly to achieve fine results. Frances Bangs, the Alumni Association representative, was im-

measurable helpful in making the 50th a success. Although **Nick Flately** was in Washington, his guiding hand was always felt.

Short notes from **Russell S. Robinson** and **John A. Osterman** stating they were looking forward to the trip back to Cambridge to celebrate the 50th. . . . **John Lawrence** has been named temporary president of Recognition Equipment, Inc., Dallas, Tex. . . . **Dana D. Price** is in charge of Electrical CII Department, Bovay Engineers' Houston office. . . . **Bernard Markstein, Jr.** spent a winter month in Southern California, a great place he says to escape the Midwest cold. . . . **Rufus K. Dryer II, Harry Krutter, William C. Schoolfield, Bernard J. McMorrow, Isabel C. Ebel, Kenneth W. Smith, James E. Harper,** and **Edward R. Levine** all wrote to express reprets that they could not come to the 50th Reunion, but they sent their best wishes to our class.

I have the sad news to report the deaths of many of our classmates. **Frederick L. Mahoney** died on January 1, 1982. He was associated with M.W. Kellogg Co. in Houston and was later in refinery consulting work. Surviving are his wife, Florence, and two sons. . . . Dorothy (Mrs. **Donald**) **Freeman** reports that her husband passed away in his sleep on December 5, 1981. They were planning to come to the reunion. . . . **John Gordon Cree** died on November 14, 1981. . . . And **Richard R. Hall** died on November 22, 1981. When we receive obiturary information, we will pass it on. . . . **Jack Stover** died on February 9, 1982. He is survived by his wife and three children. He had hoped to attend the 50th Reunion.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

No headlines this time around, as the Class of 1933 took over the whole front page of the 1982 report of the Mexico M.I.T. Fiesta held in or near Merida, Yucatan, Mexico. Five members of our class attended the affair, four accompanied by their wives. The roster: Helen and **Bill Baur** of Dunedin, Fla.; Marjorie and **Prentiss Lobdell** of Longboat Key, Sarasota, Fla.; Margaret and **Gus Liljegren** from the State of Washington; Louise and **Ellery Clark** from Yucaipa, Calif.; and last but never least, **Bill Huston,** of Bowie, Md. (race hosses), but no wife this time. Mebbe she hadda mind the store. So, and forsooth, it was announced that 1933 was the annual champion, having five classmates attending. And Prentiss Lobdell was given the traditional "Eager Beaver" award for having attended the fiesta four times. Not many of our boys have that honor; in fact only one, me. I got mine approximately 10 years ago. One of ours sent me a list of attendees; M.I.T. men from all over. Mebbe it was **Bill Huston,** no? Aside from 1933, there were several close friends of our class, to wit, Luisa Cornish, widow of ole **Nish Cornish,** who, if one founder were picked, Nish was the one, for sure. Luisa, we miss seeing you, and we miss Nish. Another fixture of many fiestas is Conchita Lobdell, who married our old dean, active when we were students. Unfortunately, Lobby passed away far too soon after his marriage. Later, the lovely and loyal Conchita married again. Her present married name is gone from me. However, she always takes in the fiesta, and many events in Cambridge. I see her quite often. I noted with satisfaction, that **Joe Martori** was in attendance. I recall telling **Don Severance,** when he was alumni secretary, that Joe was a hard worker and a comer. I understand that he is doing well, indeed. More power to you, Joe.

A word about the locality of the 1982 Fiesta is in order. Folks, go to Merida to visit the Mayan Archipelago, on the tip of Yucatan. The ruins, still there and secure, are far, far older then the Pyramids of Egypt. They are acknowledged to be the oldest provable man-made ruins anywhere, and this by far.

Now, enough for this historic subject. I honestly regret getting past the age where I can attend such a function. **John Longley** comes through with his 1982 family letter and, as usual, full of news enough to take up all the space allowed any one class. The meat is something like this: eldest son Jim works for the N.Y. Telephone Co., doing real well. John himself is still a volunteer fireman, home town, and enjoys the action on occasion. Second son Bobby is the only known family artist. He is a painter, and doing well (no houses). Two younger boys work at the Florida Disney World. The lovely Lillian has been having her own troubles: first a gall bladder operation, then a pulmonary embolism after getting home. She had to be rushed back for further medication. Obviously, she is taking it real easy and will have to for a long time. John sees **Fred Johnson** once in a while, but we don't hear from him. Thanks, John, see ya. June '83, maybe. . . . **John J. Hamlon** has just been awarded the very first award given by the 50,000-member American Public Health Association, for distinguished service in his field. He began as an environmental and sanitary engineer at M.I.T. in 1933. We note this as a very distinct honor. . . . We have a dandy clip from the *Charlotte News,* which mentioned **Beau Whitton** in connection with a Mayor's Charity Ball. The gist is pithy: "He was first known as Earle's boy, then as Daphne's husband, then as Margaret's father, and recently he was introduced as Will's grandfather." And here we always thought that Beau was a really noticeable individual. Good for you, Beau, we are glad we know you (by any set of circumstances). . . . We have a few Fund capsules, always a help. **Leighton R. Rockards** gives us a bit of background. He is with Naval Facilities Command, Engineering, currently working in energy management and conservation in San Francisco. All four children are living on the West Coast; two daughters and families are living in Central California, and patent attorney son and his younger sister are living in Seattle. . . . **Converse W. Sweetser** announces that he retired four years ago after 43 years with Grumman. . . . **Ken Moslander** announces that he has just returned from an IESC assignment in Monterrey, Mexico, their fourth. Visited Acapulco, Puerto Vallarta, and Mexico City on their way home.

Please forgive us for adding a small bit to the current effort to raise an enormous sum of money for our 50th Reunion gift to M.I.T. I hope all of you understand that you still owe M.I.T. for a large part of your tuition. Even using figures of those old days, we paid less than half of what we really should have. I have paid my back dues, and if you all come through with what you consider the other half it would be a tremendous help. What are your children paying these days? M.I.T. is a major operation, many times the size of our school, and must have the top dollar of what you can stretch to give.—**Warren J. Henderson,** Secretary, P.O. Drawer H, Exeter, NH 03833

34

As **Bob Franklin** is getting very busy for a trip to Europe, he decided wisely that it was time to make some use of his willing assistant. He also told me to bring to the attention of all that both of us would be away at the same time for much of late May and all of June. When you see this in July it will explain why letters have gone unanswered.

The notes this time are very short and very sad with only one bright spot. **Melvin Sousa** writes that he is retired and raising navel oranges in the San Joachim Valley and breeding thoroughbred horses for race tracks and show rings.

The Alumni Office has informed us of the loss of three of our classmates. **Milton G. McDonald** passed away September 28, 1981, and his wife in informing the Office of the fact included a nice gift to the Alumni Fund in his memory. . . . **James B. Kendrick** passed away on December 12. . . . The notice of the death of **Francis M. Buresh** on November 2, 1981, was accompanied by a clipping that told of his birth in Iowa and attendance at Coe College before coming to the Institute. He was an engineer at the former Fisk Rubber Co. in Chicopee, before moving to Ausable Forks, N.Y.

On Sunday, March 28, Colonel Haskell Small, '30, generously invited about forty M.I.T. graduates of our vintage and older to a delicious brunch at the Cosmos Club here in Washington, where we heard an excellent presentation by representatives from the Institute describing the benefits of contributing to any one of the various funds that the Institute has, such as the McLaurin Fund. It was pointed out that such gifts can be credited to your class and, in our case, to the 50th Reunion gift.—**Robert M. Franklin,** Secretary, 620 Satuckett Rd. (P.O. Box 1147), Brewster, MA 02631; **George G. Bull,** Assistant Secretary, 4601 N. Park Ave., Apt 711, Chevy Chase, MD 20015

35

We received the following note through the Alumni Fund Office from **Richard L. Parli:** "I am still active in the real estate appraisal field with my son Richard working with me as an associate. Gave up my architectural practice several years ago as it became too demanding. Daughter Lynn Modecki lives in Swampscott and has three lovely children. Husband, Carl, is executive director of the Masschusetts Bar Association. Virginia and I are both in excellent health and hope to be around for the 50th Reunion. . . . **Edward Woll,** a retired vice-president of G.E.'s Aircraft Engine Group, has been elected a fellow in the Society of Automotive Engineers, in recognition of his contributions to the advancement of aircraft engine technology. Ed joined G.E. in 1946. He was responsible for the conversion of small military engines to commercial service. In his more than 30 years with G.E., he served as engineering manager and general manager of the Small Aircraft Engine Department and general manager of G.E.'s Military Engine Division. He was elected a vice-president in 1968. He held the position of vice-president and general manager of the Aircraft Engine Group Engineering Division from 1970 until his retirement in 1979.

Rhoda and **Bernie Nelson** never did get away on their trip to Texas as Rhoda had a heart attack on February 26 and ended up in the hospital for a 12-day stay. She is feeling well again and is already looking forward to a planned trip to Europe in September. In the meantime Bernie has heard from some of the area vice-presidents and is waiting to hear from others on what they are planning to do with the proposed "Dutch treat" mini reunions. We have also learned that Betty (Mrs. **Leo**) **Beckwith** was in the Beth Israel Hospital for surgery in late February, but have no further information. I am sure we all wish full and speedy recoveries to Rhoda and Betty.

The only bit of news I can add is that the surprise spring snow storm that dumped up to a foot of snow hereabouts put some ice in my path on a downtown street, which ended up with me going down like 190 lbs. of bricks, cracking my head, my glasses, and one rib. I hate to think of what it will do to an already hurting golf game. Have a good summer. Please note my new address.—**Allan Q. Mowatt,** Secretary, P.O. Box 92, Newton, MA 02195

36

The current news is sad except for one exception: **Laddie Reday** writes that he has been trekking in Tibet and to Mt. Siguniang in Sichuan Province, Western China. He reports rough weather, cold, and snow in the Himalayas, but spectacular scenery and very friendly people. Well, I have news for Laddie—come to New England. I have just returned from Big Bend where the temperature rose to over 100 degrees followed by an April blizzard and more snow than I have seen in several years. Ah me!

From his widow comes the news of the death of Halsey A. Weaver on September 6, 1981. He lived at 181 Anchorage St., Fort Myers Beach, FL 33931. . . . Also, from his widow, news of the death of **Arthur F. Ordas** on January 16, 1982. He lived at 18910 N. Coldwater Rd., Huntertown, IN 46748. I have no further information on either classmate except that Halsey was previously in the construction business in Concord, N.H.

In biographical information for our 45th, **Larry (Lawrence G.) Peterson** noted that he had joined General Electric in Schenectady in 1937 and stayed there until retirement. He started in electrical engineering and switched to accounting and financial management. He writes: "Although the winters (in Schenectady) are getting harder to take as infirmity increases, we both enjoy the four seasons—the lush greens and the autumn colors—and the proximity of lakes and mountains." One of Larry's hobbies has been "railfan activities and train trips." . . . Another Pete, this time **Francis S. Peterson** of Beacon, N.Y., reports that he has retired as senior technologist from the Texaco Research Center. He had been with Texaco for 42 years and was originally hired because of his writing ability. He contracted polio while in the Army in World War II and was retired as a major. His physical problems have not kept him from getting around by car in this country and in Europe. . . . **J. F. (Pat) Patterson** had not retired at reunion time. He was manager of financial control projects in the Linde Division of Union Carbide Corp. He has been active in affairs in Pleasantville, N.Y., where he lives and is a member of the board of directors of the Westchester Association of Retarded Citizens. He has managed with Marian and his daughter, Marcia, to do a good bit of traveling and also enjoys "a small place in the foothills of the Adirondacks." He is looking forward to retirement and perhaps by now he has.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

37

Your assistant secretary spent February and March in Del Ray Beach, Fla. **Leonard Seder** and his wife, Genevieve, were there from February 15 to March 15 and we saw each other often. The four of us also visited **Joe Smedile** and wife, Martha, at their lovely villa on the intercoastal waterway in Del Ray, and then all went out to dinner. It was a great pre-45th M.I.T. mini-reunion. Pearl and I also visited Dr. **Bernard Ross** and wife, Irene, at their home in Port St. Lucie, Fla., and had a very pleasant visit. Bernie is continuing his full-time practice of internal medicine and cardiology.

By the time you read this, our 45th Reunion at Martha's Vineyard and Cambridge will be history. I hope that we had the privilege of seeing many of you. At the time of this writing, more than 50 classmates have signed up and we are expecting more than 100 people to attend.—**Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside, Medford, MA 02155

38

A follow-up on **Lloyd Bergeson**'s Wind Ship Development Corp. Bergy's project was selected as one of the ten outstanding achievements of 1981 by the National Society of Professional Engineers. . . . **Dick Muther** is spending some time in China this year, working on a project to help speed materials-handling productivity in that country. . . . **Andy Stergion**, who joined Corning Glass in 1946, was recently named manager, special projects, Manufacturing and Engineering Division. . . . **Norm Leventhal** picked up another non-paying job: a directorship in the United Way of Mass. Bay. . . . **Don Severance** reports having dinner with, and attending the Technology/Rochester Symposium with Polly and **Fred Kolb**. Fred is still with Eastman, but has been vacationing in France and California.

Charley Donlan, who retired from NASA in 1976, reports that he is working as a part-time consultant for the Institute for Defense Analysis. . . . **Jim Maguire** writes that he retired last December after 31 years with Monsanto. Jim's last working years were in personnel and industrial relations. He was vacationing on the Cape last fall, where he came across **Paul O'Connell**, who has just completed a successful career with the MBTA. Jim recently returned from Ft. Myers Beach, where he saw **George Morel**. George was hospitalized with a serious heart lining infection but has now fully recovered and is living at Sanibel Island. Jim has also seen Marge and **Walt Johnson**, who are building a new house and dock; **Tom Bjorkman**, **Dave Wright**, and **Fred Dubois** at M.I.T. Club meetings; and **Claude Parish**, who also retired from Monsanto, but has started a second career with a firm of consulting engineers in St. Louis.

I recently received a note from Ruth (Mrs. **Abe**) **Levine** informing me that her husband passed away last September. Abe, you will recall, was Course V and was a chemist with National Starch and Chemical Corp.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

39

Jean and **Barry Graham** retired after a full career with Alcan to a lakeside home in Ontario, Canada. After flying around Canada and the U.S. for 23 years to explore the best golfing and fishing locations, Barry sold his Cessna 180. He was sorry to see it go, partly because it probably contained some aluminum that he helped smelt and fabricate. Barry and Jean visited Hong Kong, Canton, and Peking last autumn where, from a 35-foot sailboat they enjoyed the spectacular sights of the beautiful Hong Kong harbor. They are back in Canada and, to further offset the grief of parting from his airplane, Barry bought two sailboards. One sailboard is for himself, and the other is for his youngest daughter whose assignment will include staying close to the "old man" until he learns how to survive whilst maneuvering in winds and waves near their lakeside home.

Veronica and **Harold Pope** live the good life from their ideal base in New Hampshire. They traveled recently with **Walt Mykytow** and his wife to Florida to watch a space shuttle launching. Harold did not mention details, but one might guess that his prestigious position as chairman of the board of Sanders Associates opened the doors at Canaveral to one or more VIP lounges. . . . Betty and **Ryder Pratt** live in St. Louis but tour Europe often. On return trips to the U.S. they visit six grandchildren and attend to several plants, which are part of Ryder's industrial complex. . . . **Walt May**, executive vice-president of product and engineering at Mack Trucks, Inc., was recently elected a fellow of the Society of Automotive Engineers. Walt's citation mentions outstanding achievements in truck design, including leadership in developing the Mack Maxidyne diesel engine. Congratulations, Walt. Your classmates bask in the reflected light of the glories you earn.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

40

When you read this, the Class of '40 mini-reunion will be a thing of the past. I hope those who attended had an enjoyable and interesting time.

The April issue carried sad news regarding Jean and **Martin Rosse**'s home and belongings in Strawberry, Calif., which were destroyed by a mud slide in January. On March 3, Martin died at the Marin General Hospital after a long battle with cancer. He had his own architectural firm in San Francisco. Prior to that he had been associated with the firms of Wurster, Bernadi, and Emmons; Stone and Mulloy; John Carl Warneke; Charles Warren Callister; and the late John Morgan Payne. Concentrating on schools, churches, and parking structures, he received merit awards for a school in San Mateo County and for designing the Unitarian Center at the First Unitarian Church in San Francisco. Martin took active leadership roles in both community and professional affairs. Both he and his wife, Jean, served on the Educational Council of the Institute.

The Department of Electrical Engineering (Course VI) will be 100 years "young" this fall, and plans have been made for a big celebration on Saturday and Sunday, October 2-3. This Centennial, to which all of the 11,000 alumni have been invited, led the department to revive its newsletter, *EE&CS*. Professors Robert M. Fano and Louis D. Smullin are the co-chairmen of the Centennial committee. Electrical Engineering became a formal course (VIII-B) within the Physics Department in September 1882. Its designation was changed to Course VI two years later and it operated under the aegis of the Physics Department until 1902, when it was established as a separate administrative unit. As previously reported in this column, the department, in cooperation with the M.I.T. Press, commissioned Karl Wildes, professor emeritus, to research the history of electrical engineering at the Institute. Nilo Lindgren, who writes about the history of science and technology, has worked with Professor Wildes to produce a draft of this book. It is hoped that the completed volume will be available in time for the Centennial.

W. Kenneth Badger writes that, even though retired as professor of engineering at California State University at Fresno, he is still teaching half time as well as enjoying his retirement. . . . **Samuel Scott** is still practicing architecture from his office in Wellesley, Mass. His practice, along with his three children and six grandchildren, helps to fill the void left by the recent death of his wonderful wife, Ginney.

The Resources Development Office recently provided me with a booklet explaining the M.I.T. Sustaining Fellows Program.For those not familiar with this program, it was established with the following objectives:

☐ To attract and recognize individuals who would like to assist M.I.T. in carrying out its mission, through financial support.

☐ To provide interested individuals an opportunity to learn about M.I.T. research and teaching programs.

☐ To establish a widespread network of men and women who are informed about M.I.T.'s purposes, can promote active discussion of them, and can help the Institute's leadership formulate goals.

Each year, the Sustaining Fellows will be invited to take part in special M.I.T. programs and seminars, will receive selected M.I.T. publications, and will be kept informed of important M.I.T. developments, activities, and contributions to public service.

If you would like more information concerning this program, may I suggest that you contact Barbara Lewis, M.I.T. Sustaining Fellows, M.I.T., Room 3-231, Cambridge, MA 02139. (617) 253-5176.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

41

Luke Hayden has been named chairman of the City Savings Bank of Pittsfield, Mass. . . . **Gene Gwaltney**, president of the Russel Corp., has been elected to the additional post of chairman. . . . **Ken Roe** was appointed chairman of the Industry Advisory Committee of the American Association of Engineering Societies. He also received the Stevens Institute Honor Award for 1981. . . . Dr. **Charles Papas** was awarded the "Distinguished Diploma of Honor" by Pepperdine University. . . . **Joe Gavin** was elected to the board of the Charles Stark Draper Laboratory.

Bill Bowes is a test engineer for TRW, working on magneto-hydrodynamics using a COA/Combustor. His address is 34585 B Via Verdo, Capistrano Beach, CA 92624. . . . **Charlie** and **Edith Corliss** have retired from the National Bureau of Standards and have set up their own Forest Hills Laboratory for research and development on optics acoustics. They welcome inquiries. . . . **Charlie Sauer** is in Tonowanda, N.Y. (4421 Chestnut Ridge, zip code 14150), and is specializing in strategy planning.

We have been notified of the passing of Russell Lamb of Leicester, Mass., and of **Henry Faul** of Philadelphia, Pa. Our condolences to their families. . . . Please send in any items of interest. We will publish them.—**Henry Avery**, Secretary, 440 Totten Pond Rd., Waltham, MA 02154

Nanu Amin, '42

42

Congrats to **Jack Flipse** on his election to the prestigious National Academy of Engineering. The citation mentions his "outstanding leadership in marine mineral resource exploration, research and development." After graduating from Course XIII, Jack taught naval architecture at the U.S. Merchant Marine Academy, served in the U.S. Coast Guard, taught at the New York Maritime College, worked for Sperry Gyroscope developing fin stabilizers for naval and merchant ships, was director of research at Newport News Shipbuilding and Dry Dock Co. and is now professor of civil and ocean engineering at Texas A&M. Some busy career!

There's a fine cover story in *Business World*, the magazine for Indian business, on **Nanu Amin's** Jyoti, Ltd. I can't really summarize the ten-page article here, but I'll be glad to send copies to all who want them. Just drop me a line. Jyoti manufactures pumps, electric motors, generator sets, switchgear, transformers, and fans, and it now has a division heavily committed to developing and manufacturing solar energy equipment.

With the news this scarce I'll have to resort to a personal bit. I was elected associate treasurer of the Union of American Hebrew Congregations (UAHC) at its biennial assembly in Boston. The UAHC is composed of 760 Reform Jewish congregations totaling about 1,300,000 members in the U.S. and Canada.

The time of writing is April 8, the day after our foot-and-a-half deep spring snow storm. By the time you read it, I hope our snow will have melted, so best wishes for a happy and healthy summer. Send News!!—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

43

William A. Verrochi, Course II, has been named president and chief operating officer of the Jersey Central Power and Light Co. According to the *Alumni Directory*, Bill lives in Johnstown, Pa., and works in Parsippany, N.J. . . . *The Wall Street Journal* reports that **Stanley Cohen**, Course X, became chairman of Central Hardware Co. on March 1. Central Hardware operates home improvement centers and is a subsidiary of Interco, Inc., a maker of apparel, furniture, and shoes. . . . Information continues to issue from Stanford about **John Linvill** and his Center for Integrated Systems on the Palo Alto campus. The latest item is an article authored by John in the February 12 issue of *Science*, "University Role in the Computer Age."

Selecting names to call for information to fill out a class notes column is strictly a matter of chance. I picked on Dr. **Andrew C. Peacock** because he and wife **Gloria Kay** were classmates in Course VII, so I could get two with one note. Andy and Gloria live in Rockville, Md. He specializes in the analysis of nucleic acids at the National Cancer Institute in Bethesda. She is the activities director at a Silver Spring nursing home. They have three grown children, one of whom is an authoress with a recent book to her credit. Andy says he likes to travel and enjoys playing the flute. We can perhaps assume that Gloria accompanies him in both endeavors.

Fortieth Reunion Chairman **Jim Hoey** has unveiled his plans for the big bash June 2-5, 1983. Thursday evening there will be the customary buffet for reunion classes, followed by the Pops concert at Symphony Hall. Friday morning we tour the campus (or whatever), and then attend the Alumni Luncheon, where we will hear the extent of our munificent 40-year gift now being solicited by **Stan Proctor** and his cohorts. Friday afternoon the class departs for Falmouth, transportation furnished, to spend the next 48 hours or so in riotous living at the fabulous Cape Codder Hotel. The Cape Codder is currently being renovated by the Hotels of Distinction chain, which restored Boston's venerable Copley Plaza to its former opulence and prestige. Set on a promontory overlooking Buzzard's Bay, the hotel offers the best in recreational facilities: swimming pool, golf course, tennis courts, boating, fishing, and shopping in Falmouth. Besides eating and socializing, the program includes a clambake, a cocktail party, and a dance. Plan now to renew old acquaintances and enjoy yourself at our 40th.

Only 400 more names on the mailing list to hear from.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

I wonder how many of you who are complaining of the heat when you read this in July can recall the blustery day with snow flurries we endured here in the Northeast the week before Easter (as I write these notes). A little of that arctic air would probably be appreciated now.

Kenneth L. Keating writes that he is now in his 21st year as a professor of metallurgical engineering. He says, "It beats working!" (Ken is at the University of Arizona in Tucson.) . . . **Hilliard Roderick** writes, "After 16 years in Paris as first director of environmental affairs, promoting public interest scientific research at OECD, and prior to that at UNESCO, I moved to England two years ago, where I am now at the Medical Research Centre, University of Sussex. I am working as a consultant on international environmental and science policy matters. At present, I am directing a study for the West German government on the feasibility of setting up an international program to identify environmentally hazardous chemicals from among the 50,000 chemicals now in world trade."

My Newton (Mass.) newspaper of February 17 contained an article on a "portable computerized insulin pump" and its wearer **Jill Witherell** (nee Egilda DeAmicis). Jill is a radiological physicist at the Newton-Wellesley Hospital and appreciates this modern medical approach to diabetes. . . . Also, **Joseph Alexander**, president of the Newton Taxpayers Assn., is reportedly working to see that municipal benevolent funds are not improperly used. Joe was also in the news at a later date expressing his concern with the extremely high valuations placed upon some Newton homes during the 100 percent revaluation process taking place. It's comforting to know that a classmate is working for your interests. . . . A recent *Tech Talk* noted the death, at age 83, of Thomas P. Pitre. Most of us remember him as associate dean of students. . . . Another *Tech Talk* noted that charges for tuition and room and board at M.I.T. the academic year 1982-83 will be $12,250. That works out to be more than twice as much as our total costs were for four years at M.I.T. The minimum wage has increased tenfold since our undergraduate days, and yearly college costs have kept pace.

Peter D. Matthews writes that he is still cost treasurer at the Draper Lab, having put in 32 years at the lab. His son Pete, Jr., is a section leader in the computer-user services section there. His other son Don is a lawyer and a local politician in Needham. Peter's wife is an ordained UCC minister with an ABC church in Exeter, R.I. (Last month we reported on daughter Andrea's accomplishments.) . . . Hope the summer brings you a fresh outlook on life.—**Melissa Teixeira**, Secretary, 92 Webster Pk., West Newton, MA 02165

45

My records indicate that our last notes were about a year ago—by far our worst performance in 32 years. What more can one do than apologize!

We shall return to our 35th Reunion and Wychmere Harbor Club, June 1980. Should we mention a name or situation that causes you to scratch your memory, please drop **Bob Maglathlin** a line at 601 Grove St., Norwell, MA 02161 and ask him to forward a 25th Reunion booklet, as he still has a few collecting dust in his attic (or is it mildew in his basement?).

In random fashion: **Marshall Byer**, 921 Vestal Rd., Vestal, N.Y.—IBM, productive assurance which means, I believe, reliability engineering! Daughter Deborah, married, graduate school, Syracuse University; daughter Judy, married with daughter living in Branford, Ontario, working in graphics; daughter Linda, University of Minnesota, large animal surgery. . . . **Enrigue J. DeMajo**, construction machinery importer in Venezuela. As for his kids (young adults!): daughter, 31, traveling; son, 30, working for dad; daughter, 27, ecologist, socialist; son, Oklahoma City, business administration; son, 18, student in architecture. . . . **Peter P. Agoston**, Scarsdale, N.Y., administrative assistant to vice-president/manager Pfizer Inc., New York City. Children: Stephen, 27, New England College of Optometry, Boston; Thomas, 23, UCLA Law School; Margie, 17, St. Lawrence University. It is obvious that skiing keeps Peter and Eva both young looking and thinking. . . . Some time ago, we reported that Ellen and **Jim Brayton** has retired to Little Compton, R.I., but we failed to report that Jim had turned in his Pearson 30 sloop for a 26-foot bass boat. Oh well! Children: Flint, 30, married, Ph.D. computer science, Federal Reserve Board, Washington, D.C.; Dana, 27, a Seattle, Wash., composer; Leslie, a Boston restaurateur. In the way of update, I had luncheon with Jim in Providence last December and learned that he still sails—now on other peoples' boats, even offshore on classmate **Jake Freiberger**'s Hinckley 40.

Albert E. Bowen, Jr., of Old Greenwich, Conn., continues as owner of a Manhattan-based freight forwarding business started by his father; however, Al has branched out into the ship charter business which is a high risk, high leverage operation with the rewards and failures one could expect in such an operation. Wife Billie bides her time as the town's leading seamstress (it used to be real estate and politics), while Laura, 31, a Boston University graduate, lives in Peabody, Mass.; Greg, 29, an engineer from Tufts plus Wharton School is married and is with Philadelphia Resins in Philadelphia; Andrea, 28, has done graduate work in forestry at the University of Washington, and is single. For the moment, we have misplaced (lost!) the balance of our June 1980 notes so we shall turn in random fashion to the very few clippings that have trickled in this past year.

An update on **William G. Martin, Jr.**: a Johnson Controls retiree after 32 years, he now resides in Darien, Conn., as a manufacturers rep. He is working harder and loving it, has three married children plus one single; two grandchildren plus two more expected. He says, "Jeanne and I are happy, healthy, and enjoying life." . . . **Jeptha H. Wade**, a partner at Choate, Hall and Stewart in Boston, continues to serve on many corporate and charitable boards, including the Cleveland Cloffs Iron Co., Adams-Russell Co., Boston Museum of Fine Arts, the Children's Museum in Boston and, most recently, Historic Deerfield, Inc. in central Massachusetts. Jep and Paddy continue most active in both corporate and alumni activities at the Institute; they are both life members of the M.I.T. Sustaining Fellows.

And now for Christmas in July! The usual unusual greeting from Edna and **J.J. Stranad** with its collection of family views or snapshots with such wonderful captions as: "Edna ran the Western Reserve Antique Show while Budd ran Lempco; Nina, after a busy qualifying exam is back in the lab in Boston; Professor Jeff Stranad, University

of Southern California Law School." . . . A great note from **Tom Stephenson** indicates that he spent 90 percent of 1981 in the air traveling between Alcoa headquarters in Pittsburgh and two new smelter projects in Brazil and Australia. If our report on Steve's September visit to Lou and **Pete Hickey** in Topsfield, Mass., is at all accurate, Steve is still Steve, just several years older and a few steps slower! . . . And **George Dickford** has the perfect message for us all: "Hang in there!"

Louise and **Tom McNamara** continue to see the world; 1981 was their year for Egypt and Israel. . . . We have a nice note from Norma and **George Hetrick** of Lancaster, Pa. . . . Goodness, but Julia and **Sherry Ing** have a photogenic family. . . . You will all be pleased to know that Jan still addresses and writes the **Charles Paterson** cards. . . . A nice note from Jean and **Chris Boland** as follows: "Now recovering from Sue's wedding on December 19 at home with 120 guests following Kirby's in September. Dick is to marry a Wellesley girl he met at M.I.T. in June in Cleveland. Laura is a buyer at A&S in Brooklyn, while Tom is a senior at the University of Washington in Seattle. Beth is off to college in September. Jean is traveling the world—Spain next week while I celebrated 25 years at Kidder Peabody!"

A heartwarming note from **Nick Mumford** advises that he remarried in June (you may recall that Nick had become a widower a second time Thanksgivinng Day, 1979). As Nick reports: "The big news is that I met and married Carol this year. She was a widow whose children were also grown. Between us, we have 12—mine, hers, and theirs—also nine grandchildren. Since June, we have been to both coasts to see and meet new family. I continue working at and for the church part-time, three plus days a week; it continues challenging and rewarding." Nick, we are all happy for you.

Mary and **Jim Hoaglund**'s Christmas letter gives a complete family history for 1981. My problem is my failure to remember which is whom and why, as my mind goes back to those three delightful tow heads by the names of John, Judy and Nora that sat on the rocks along side the Harwichport breakwater in June 1960! Seriously, John at age 29 complete with family has started law classes at night. Judy, 27, has had a fascinating and rugged year with the Peace Corp in Chile while Nora, 25, is completing five years at Onan Corp. as a program analyst. In July, Mary retired from her job with the state to such mundane items as free-lance educational evaluation, local Wellesley Club, golf, tennis, neighborhood collection, etc. Jim, fortunately, has had a quiet year—for him, that is—as he continues as executive vice-president of McQuary Perfix, Mich. Earlier this year, Jim's firm purchased the commercial/industrial and conditioning division of Westinghouse, which undoubtedly has him back up to his arm pits. . . . Tally ho—and have a great summer.—**Clinton H. Springer**, Secretary, Box 288, New Castle, NH 03854

46

Got the nicest letter from **Don Burke** just before deadline. In case you haven't been in touch, Don joined partners Fischer, Johnson, and Allen five years ago, underwriting municipal bonds and financing public works. Sounds quite successful! And knowing Don, why not! He invites us all to visit their beautiful offices overlooking St. Petersburg waterfront or his home in Lakewood Estates. There are "lots of bedrooms" now that the kids are gone. Oldest son, Richard, is an environmental sound/noise engineer with R.H. Parsons in Pasadena; Bob is a C.P.A., finishing up at the University of Southern Florida; Barbara's getting a Ph.D. in speech science at Florida State; and Bill soon graduates from Georgia Tech as a mechanical engineer. Don and Pat are still close friends of the **Don Robinson**'s. Don R., Course XVI, is a St. Pete native (of all things) from whom we'd like to hear. Don B., in his modest way, didn't mention it, but I just found his name listed as life member of our Sustaining Fellows program. I also found out he was involved in doing our class bio's for the 1946 *Technique*. If you'd like to write or visit, his address is 1818 Caeser Way S., St. Petersburg, FL 33712. Or give him a ring at home, (813) 867-1576 or at his office, (813) 821-3182.

And yet another invitation from sunny Florida, this time from **Bill McEwan**, who retired to the Fort Myers area after toiling for ITT in North Jersey for the past 28 years. Bill and his wife, who's also retired from her law practice in Newark, aver their "worst necessary commute is the few steps across the patio into the pool." If you get down that way, look him up: 303 Lake Ave. N., Lehigh Acres, FL 33936. . . . Quick squib from **Jack Hinman III**, telling us that he's an associate professor of aviation management and chairman of the Aviation Management Studies Program at Florida Institute of Technology (F.I.T.? okeee). . . . One of the "perks" of this secretarial job is getting a free class roster (woweel) through which I browse in my spare moments, playing the game of "whatever-happened-to" and discover some interesting, even amazing things like. . . **Bob Zucker, Jim Chabot**'s old roomie, has been associate professor in the aero department at the Naval Post Grad School in Monterey for Lord knows how long, and lives in painfully beautiful Pebble Beach. And to think of all those years I went scuba diving down thataway and could have dropped in on ol' "Zuck". . . . Or like, **J.R. "Jerry" Wilson**, an old roommate I lost contact with in 1951, is listed as a project engineer with the Marchant Division of SCM and living in Berkley, Calif. Jerry, are you listening?

In Memory. We've lost a couple of good people. **Jim Buttolph**, who attended briefly in 1945-46, died on January 5. His wife informs us that their daughter, Maria Lynn, is presently a Ph.D. candidate in nutrition and food science at Tech. . . . **Allan Bralove**, with both a B.S. and M.S. from Tech, was felled by a heart attack on March 5 while in Fort Lauderdale, Fla. Allan, who had sailed around the world the past ten years, is survived by his wife Jacquelyn and three daughters.

Missing Members. Maybe you can help us find some of our missing members. We got a list of these prior to the 35th, but I've lost it and hope **Jim Goldstein** will send me a copy. What I *do* remember were old friends **Mario Vinci** and **Pete Wright**. Mario was last seen in Santa Ana, Calif., while Pete was last heard from somewhere in Connecticut. In subsequent issues of the *Review* (provided I get the list), I will continue to list some missing members with the hope that one of you will send me word of their whereabouts.—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

48

Ed Frohling, president and chief executive officer of Mountain States Mineral Enterprises, Inc. has been named 1982 recipient of the Charles F. Rand Memorial Gold Medal by the American Institute of Mining, Metallurgical and Petroleum Engineers. The award, established in 1932, is presented for distinguished achievement in mining administration, including metallurgy and petroleum. Ed founded Mountain States Mineral Enterprises in 1969 to provide engineering services to the copper mining industry in areas near its headquarters in Tucson, Ariz. In the 13 years since, the company has become a major U.S. engineering-construction firm serving the minerals industry worldwide. Recently, Ed was elected first vice-president of the 16,000-member Associated Builders and Contractors. In awarding Ed the Rand Memorial Gold Medal, AIME cited him for "inspirational leadership and management skills brought to the minerals and construction industries resulting in the founding and successful administration of his company."

Bob Crane wrote that he is director of clinical research for the Sterling International Group (Division of Sterling Drug, Inc.). After completing a year and a half of grueling work as resident in internal medicine at Bronx-Lebanon Hospital, Bob shifted positions in January. He is using his training in bioengineering and medicine fully. He immensely enjoys his new lifestyle: living and working (within walking distance) in Manhattan. His office is around the corner from the M.I.T. Alumni Center and he invites classmates to drop in when they are in the neighborhood. . . . **John Kaymen** is planning to move back to Connecticut. His oldest daughter, Amelia, is an M.D. interning at St. Lukes, New York City. Daughter Harriet is completing two years in the Peace Corps in Zaire. Stan, his youngest, has spent two years in France learning all aspects of the wine business and is planning to obtain an M.B.A. here or abroad. At present he is in Wiesbaden perfecting his German. . . . **Ken Jarmolow** is director of corporate research for Martin Marietta Corp. Ken recently represented his company at the formal presentation of Martin Marietta's unrestricted grant of $25,000 to M.I.T. The grant will be under the direction of Professor Patrick Winston for work in artifical intelligence.

Fred Richards and his wife Sara received honorary degrees from the University of New Haven. Fred has been a member of the Yale faculty since 1955 and is noted for his research on the structure of enzymes; Sara is a marine biologist noted for her studies of the inshore fish population of the southern New England region. Sara started the Little Harbor Laboratory in Guilford, Conn., a small teaching, consulting and research marine laboratory. . . . **Henry Kohl** continues as a department engineer for the fabrics and finishes department of duPont. He and his wife own a small plane and fly hither and yon. Their three children are grown and gone; they have one grandson, eight years old. . . . **Bob Gurney** has built two recumbent bicycles. The recumbent position is very comfortable, with excellent seat and back support of stretched canvas, although pedaling with legs horizontal requires some muscle adaptation. The upright head position provides a better view of the road and traffic. Because of a lower seat there is less wind resistance, and the center of gravity is lower. Bob believes there may be a market for his recumbent design.

In March, Judy and **Graham Sterling** hosted a cocktail party for classmates. Their home is in Norfolk, Mass., and 18 of us found our way there. Nancy and **Jim Mason**, Agness and **George Fountas** and **Bob Welsh** joined class officers and regulars for a delightful party. Five other classmates have volunteered to host parties during the next seven months. All classmates are invited to attend, but each host is using his own approach to extend the invitation. Give me a call if you would like to be a guest or host for a Class of '48 cocktail party. . . . Thanks again for the mail; I'm holding over some news for next issue.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

49

Those of you who knew **Vincent Murphy** before his death years ago will be pleased to know that his daughter Marilyn graduated from Harvard Law School, practiced law, married, and recently had a son. Vince's son, Daniel Vincent Murphy, is a staff member at Lincoln Labs after earning his doctorate at Yale last year. . . . **Robert O. Bigelow** was elected president of New England Electric Transmission Corp. This company will build the first transmission interconnection with Canada's huge Hydro Quebec. (Did you read the article in March's *National Geographic*?) . . . **James R. Cowdery** has his own consulting firm in Pelham, N.H., specializing in materials handling and power transmission. . . . **Sidney Howell** was named executive vice-president of the Dana Corp., Toledo, Ohio, manufacturer of automotive parts. . . . **Harold Salwen**, professor of physics and engineering physics at Stevens Institute of Technology, has been appointed adjunct professor of oceanography at Old Dominion University, Norfolk, Va.

From an aritcle in the *Beverly* (Mass.) *Times* it seems we '49ers have our own home-spun philosopher and chronicler of our times in **Warren Berry**. Warren, financial manager for several promi-

nent Boston hospitals and now with Avco, Wilmington, has been on the Danvers School Committee and is now chairman of the Republican Town Committee. Such is the curriculum vitae. Now for the man himself. To quote from the article, "Warren Berry is a man people love to hate. He is opinionated and blunt, freely attacking everything from the management of the Danvers school system to federal labor laws. He embraces right-wing views with a passion and extols the virtues of high productivity for low pay with determination. He is a man who says what he believes and who believes what he says is for the public good." Do I detect a little left-wing definition of what right-wing is? But what does Warren say? Plenty! And he is trying to get his book, *There Is No Inflation,* published. The book "characterizes the average American executive, based on Berry's experiences." Some of these traits are stubbornness, little common sense, a big mouth, the ability to outshout everyone else in meetings, and "a broad yellow stripe down their backs because they are afraid to get involved with the public." Warren will continue his "hobby" until he "gets a million dollars and retires to Vermont." Independent-thinking, outspoken, non-conforming: isn't this the '49er we planned to be?

Ginny and I hope you all have a good summer. Write and tell us what you are doing.—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017

50

Richard Dobroth recently opened a real estate development firm, Dobroth and Fryer, in Lowell, Mass., after leaving Spaulding and Slye of Burlington where he was executive vice-president for eight years. Dick and his wife, Peg, built a new home in Concord Center after the last of his six children left for college. . . . **Jim Hooper** has recently been elected president of the American Civil Liberties Union of Florida. . . . **Peter W. Plumley** was elected to the Society of Actuaries board in 1981. . . . As of December 31, 1980, **Herbert F. Ayres** has been chairman of Ayres, Barry Corp. . . . **Enders A. Robinson** has been visiting professor of geophysics at Cornell University for the academic year 1981-82. . . . **Bob Wohler** happily reports a milestone as follows: "Our tenth and last will graduate from high school, and our sixth (in mechanical engineering) will graduated from college this year. It's all downhill from here!!"

Jim Goff reports that his daughter is a sophomore at Smith, where she is still deciding between math and art. Also, she is a rather good sculptress. Right now she is combining both worlds by studying computer graphics. Jim's son attends a private high school in D.C. In early 1981 Jim completed his term as president of the Philosophical Society of Washington, the scientific society founded by Joseph Henry in 1871 and progenitor of many things in D.C., such as the Cosmos Club of which Jim is also a member. He has also been elected president of the Washington Academy of Sciences. As for his career, he has moved from straight research and has entered the line management of a Navy laboratory in Washington. He represents the Navy on an international committee which involves the English-speaking countries and is concerned with certain aspects of materials. Jim has also been concerned with thermoelectricity for the past six years. He and his wife have started backpacking in the mountains of West Virginia. . . . **John Lane** tells us he is writing to keep his mother quiet. For whatever reason, we are happy to hear that he is still at the Kearfott Division of Singer Co. engineering smaller and better gyros for inertial reference systems. Applications include the space shuttle, the F-16, XM-1 tank, and even oil-drilling rigs. John also wants us to know that his father, Ken Lane, will be attending the 65th Reunion of his M.I.T. Class this year, and John plans to celebrate with him.

We were saddened to learn of the death of **William A. Farmer** on January 5. At the time of his death, Bill was with U.S. Steel Products in Pittsburgh, Pa. He is survived by his wife and daughter.—**John T. McKenna, Jr.**, Secretary, 1 Emerson Place, Apt. 11H, Boston, MA 02114

52

Aristotle Scoledes is a Democratic candidate for the U.S. Senate in California. Aristotle has been an educator in the philosophy of science, including cognitive sciences, and an engineer on the Gemini and Apollo space programs. He is an alumnus of Stanford, Johns Hopkins, and Chicago, as well as M.I.T. . . . **Gerald M. Rothberg**, professor and head of the Department of Materials and Metallurgical Engineering at Stevens Institute of Technology, has published an article in *Physical Review Letters*, "The Nature of the Resonant 6eV Satellite in Ni: Photoelectron Spin Polarization Analysis." Dr. Rothberg is a resident of Hoboken, N.J. He joined the Stevens faculty in 1966 as an associate professor of physics and was named a professor in 1969. In 1975 he received the institute's Jess H. Davis Memorial Research Award for his extensive research on Mossbauer spectroscopy. Dr. Rothberg received a Ph.D. from Columbia University in 1959. . . . **Harold M. Sharaf** died in February after surviving nine days on a raft following the crash of his small plane February 5 near Bimini Island in the Bahamas. Harold was a resident of Stoughton, Mass., and is survived by his wife Dorothy and three daughters—Judith, Joyce, and Janet. Harold held three degrees in electrical engineering from M.I.T. He had owned Dymag in Stoughton which specialized in the manufacture of transformers and power supplies. After the Dymag sale, Harold started work for Wang Corp. in March last year. Harold was an avid boatsman and scuba diver; and since his body carried no signs of injury from the crash, the Coast Guard presumed that he had ditched his plane safely. Although the plane was equipped with a homing radio beacon, the device stopped working shortly after the plane ditched. Harold had radioed a Mayday prior to ditching, and the Coast Guard conducted a five-day search with no success. The raft carrying his body washed up at Palm Beach, Fla., where the Palm Beach County medical examiner said that Harold had survived nine of the ten days he was at sea.

NBD Bancorp, Inc., a bank holding company in Detroit, Mich., has announced that **Herbert H. Dow**, a director and corporate secretary of Dow Chemical Co., was elected a director. . . . As vice-president of The Architects Collaborative, Inc. of Cambridge, **Oazi B. Ahmed**, is primarily involved with health care projects. . . . **William B. Horner** writes that he is a real estate investor. . . . **Dirk A. Plummer** graduated from the Air War College Seminar Program in October 1981. Dirk is scheduled for retirement from the USAR on July 6, 1982, in the rank of colonel. . . . Colonel **Charles H. Bechmann** was recently appointed as clinical professor of medicine at the University of Texas School of Health Sciences at San Antonio.

Clifford C. Herdman writes that after 30 years he is still with the Port Authority of New York and New Jersey. Cliff is in the Aviation Department planning long-range development of Kennedy, La Guardia, and Newark Airports, which he finds very fascinating. . . . A note from **Edward Dickerman** says, "I have been requested to retire early with a medical disability. I have been struggling with Parkinson's Disease since 1956, but it has just reached a level the company cannot stand for I cannot give a day's work." Ed has been a senior project engineer with the Colorado School of Mines Research Institute in Golden, Colo.—**Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, CA 94301

54

March has the reputation for coming in like a lion, but this year in New England April did. Last night, April 6, Mother Nature deposited over 15 inches of fluffy white stuff on our picnic table. Today the temperature was 16 degrees Fahrenheit, with a wind chill factor of minus 25 degrees Fahrenheit. Both the snowfall and the low temperature set all-time records for any April day in the Boston area . . . meanwhile in Texas it was 95 degrees Fahrenheit.

One nice thing that is happening here this April is an exhibition of paintings and prints by Natalie (Mrs. **Bob**) **Warshawer** at the Depot Square Artists in Lexington, Mass. . . . Congratulations are also due to **Bob Anslow**, whose biography is listed in the latest edition of *Who's Who in Technology Today.* . . . **Harry Taylor** writes that he is still recuperating from a near-fatal attack of pancreatitis in June 1979. He has undergone a series of operations since then and hopes to have the final operation this year. Our best wishes go to you, Harry, and we hope to see you at our 30th Reunion in 1984. Harry is active in technology transfer from Israel to the U.S. His daughter, Alisa, recently received a master's in geology from the University of Texas in Austin. Harry also has a daughter, Maya, in kindergarten and a son, Lior, in the first grade.

Speaking of children, the Sama family has entered a new plateau of sorts. Since St. Patrick's Day when our son Frank (Patrick) became 13, we have had six teenagers in our family. John, 19 is a sophomore at the University of Vermont. Cathy, 18 is a freshman at the University of Virginia. Our 17-year-old twins, Sharon and Susan, are high school juniors, and Jim, 14 is a freshman. Congratulations to my wife Jane, who has managed to survive the seven of us in good fashion.

I am sorry to once again have sad news to report. Our classmate **James Rude** died on December 29.—**William Combs**, 120 W. Newton St., Boston, Ma 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

55

Having missed an issue, we face the happy task of reporting a number of accumulated notes. Hence, without further ado, to work. . . . From Silicon Valley, **Joseph G. Carleton** reports that he is working in Sunnyvale as a mechanical engineer for Eaton Corp., which is involved in semiconductor equipment operations. Joe is also teaching auto mechanics in a Palo Alto adult education program. His daughter Nancy has just graduated from Berkeley, and his son Jeff attends San Jose State University. . . . An IEEE bulletin notes that **Bob Craven** recently gave a report on a precision measurement system for the automatic testing of integrated circuit data conversion components. Bob designs ATE instrumentation for the industrial consumer division of Teradyne, Inc., and has over 20 years' experience in analog and digital instrumentation and circuit design. He has written a number of articles, presented papers and obtained a number of patents (hooray!) on the design and testing of D/A and A/D converters. . . . We have another periodic report from **George Goepfert**, Course X's agent in Hong Kong. George has been there for over three years with Exxon Chemical Asia Pacific. He reports that his daughters, Laura and Karen, are attending the Hong Kong International School, while his son Ian is now in his second year at Texas Tech. . . . **Paul Goldan** has also called our attendtion to his activities on the other side of the world as a guest scientist for a year (1979-80) at the West German Federal Laboratory for Atmospheric Chemistry. Forest Hills' contribution to electron capture detector technology has since authored a chapter in Elsevier (1981) and delivered a number of invited talks on electron capture detector techniques for specialized applications in gas chromatography at symposia in Houston and Las Vegas. Hope you had time for more than your invited talk while in Vegas, Paul!

Ron Howard, professor of engineering, Economic Systems at Stanford, spent part of his 1981-82 Fulbright Award year lecturing on procedures for making decisions, especially those in-

James Storey, '55

volving the risk of death, at the Tallinn Polytechnic Institute, Estonia, and at Moscow State University in the USSR. . . . Further achievements of **Russ Meyerand** (Courses VI and XXII) have also recently been brought to our attention. Russ, who has not been a stranger to this column in recent years, was named the chief technical officer for United Technologies Corp. in Hartford, Conn., early this year. Russ, who now travels under the vice president—technology label, will be responsible for the entire corporation's programs in advanced technology. His father, Class of 1925, sent us a brief note respecting Russ' achievement.

We have a reprint of a further article by **Phil Molten** from *Sea History,* summer 1981, respecting the restoration of the *S.S. China*, the old trans-Pacific passenger steamer. As you may recall from a prior note, Phil has spearheaded the efforts of the Belvedere-Tiburon Landmarks Society in restoring the ship in Belvedere, Calif. on San Francisco Bay. Anyone wishing to visit the *S.S. China* while in the Bay area should contact Phil. . . . **Robert J. Papa** delivered a recent IEEE talk. Bob, holder of S.B. and S.M. degrees in Course VIII and a Ph.D. from Harvard in applied physics, has been affiliated with the Rome Air Development Center since 1976, working on computer simulation of radar systems and radar clutter modeling. In addition to his recent talk on EM wave scattering from rough terrain, Bob has published 13 papers and is the co-author of two books. . . . From Canada, we hear from **Dave Peterson** that he has established a consulting business, Arrowhead Management Services, Inc., dealing with the management of technical enterprises and construction. Dave has recently been consulted in connection with the construction management of an enlarged port facility in Duluth, Minn., for handling iron ore.

From a point further south, we learn that **Walter G. Shifrin** was named manager of engineering and marketing for the St. Louis office of CH2M Hill, an international consulting firm of engineers, planners, economists, and scientists. Walt has responsibility for both the firm's business development and technical direction in the St. Louis area. (Walter, perhaps you might enlighten an old fraternity brother to whom a CH_2 invariably means a methylene group, what meaneth "CH2M"?) . . . We are advised that one **James W. Storey** was named the president and chief executive officer of Codex Corp. earlier this year. Codex, a subsidiary of Motorola, is a manufacturer of data communications equipment and systems, employing over 3,500 people worldwide, including over 2,000 in Mansfield, Mass. Congrats, Jim! . . . Whew, we are all out of space and information for the moment. Please keep the notes coming.—Co-Secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502 and **Allan C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

56

Our class notes contain several items from graduates of Course II. **Jere Shopf** has been named executive assistant to the chairman of the board of Halter Marine, Inc. in New Orleans, La. Previously, Shopf had been president and chief executive officer of Republic Drilling and Service, Inc., Houston, and before that was associated with Newpark Resources, Inc., New Orleans, where he served as president and chief executive officer, vice-chairman and chief financial officer, and director. Shopf was also vice-president of finance and administration of T. Smith and Son, Inc., the largest waterfront contractor in New Orleans. . . . **Charles B. Hazard III** has owned a real estate business, State Street Associates of Newburyport, for six years. Prior to that he spent six years in nuclear power and eight years in aerospace. . . . **Harvey Levine** just started in a new position as vice-president and general manager, Technical Products Division, Metex Corp., Edison, N.J.

John B. Bidwell, Course XIV and I, has joined the staff of the M.I.T. Alumni Association as data base manager. John has a broad background of work experience at M.I.T. in the Planning Office, the Office of Facilities Management, and most recently the Marine Industry Advisory Service of the Sea Grant Program. . . . **John Patierno**, Course XVI, was named vice-president and general manager of the Advanced Systems Division of Northrop Corp., Los Angeles, Calif. . . . **Robert F. Turner**, Course XII-B, has been appointed executive vice-president and chief operating officer of General Business Services, Inc., Rockville, Md. . . . **Bjron A. Rossing** left Medronic, Inc. in November 1981 and is now working for Trial Court Information System, Minnesota Supreme Court. Bjorn wrote that they were expecting another baby in February, 1982. So, congratulations are in order, I believe.

Arthur L. Sirkin, Course X, who previously was general manager of Services International, Northville Industries Corp., Melville, N.Y., is now vice-president and chief financial officer for Petroterminal de Panama, which is building the first transcontinental oil pipeline in the Western Hemisphere—130 kilometers long! According to our reunion notes, Arthur and his wife Benita have two children, Harold and Dolly. Arthur was State of New Jersey deputy public advocate, Division of Rate Counsel, helping to keep utility rates down. He has also been a member of the New Jersey and District of Columbia Bar Associations.

Keep the news flowing, we appreciate your cooperation so that we can keep you informed of the class news. Receive greetings from the Rocky Mountains, and don't forget to get in touch if you are in the area.—Co-Secretaries: **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818 and **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345

58

Joining the ranks of entrepreneurs is **Stan Klein**, who has founded Technology and Business Communications, Inc. According to Stan, "I acquired a twice-monthly newsletter on computer graphics (which I had launched jointly with Harvard University) and published a computer graphics directory. My wife, Bonnie, works with me in managing the publishing company and, sometimes, so do our children, Celestine (11), Sara (10) and Harrison (8). We all enjoy being back here in Sudbury, close to M.I.T. and alumni living nearby. My convoluted career began in the atomic energy field, veered off into professional society work, and then into writing—an interest that lay dormant during my early career, but which became an irrepressible force over the years. I have held key editorial positions involving technology subjects at *Business Week* and have written feature articles for the *Sunday New York Times* business section."

Ken Smith, currently the associate provost and vice-president for research at M.I.T., has received the 1981 Professional Progress Award of the AIChE during the society's fall meeting at New Orleans. He was cited for his fundamental research in fluid mechanics and rheology heat and mass transfer, and biological transport. . . . Time, Inc. announced that **Deane Raley** has been promoted to director of human resource development and associate personnel director. Previously, Deane was director of labor relations and before that he held successive positions as production manager, group vice-president—magazine, and general manager, magazine development group. . . . A recent issue of *Manufacturing Engineering* spotlighted **Ed Newton**, vice-president of engineering at the Gleason Works, and covered the firm's recent introduction of a new spur and helical gear machine designed to challenge Japanese and German units. In his previous capacity as director of corporate development and long range planning, Ed had been involved extensively in Gleason's diversification into manufacturing of precision engineered parts.

From Bremerton, Wash., **Jim Barber** writes, "I have worked in nuclear technology in New Mexico and California since graduation and am currently manager of the Nuclear Engineering Department at Puget Sound Naval Shipyard. Since 1967, I've been at this shipyard, which overhauls, repairs and refuels the Navy's nuclear powered submarines and surface ships." . . . Another note brings us up to date on the activities of **John Connelly** since leaving M.I.T. He obtained a Ph.D. at the University of Illinois in 1965, spent one year as a Fulbright lecturer in Madrid, and then joined MITRE Corporation for six years. Since 1973 he has been with Science Applications, Inc., and is now a vice-president of the firm.

Three interesting notes arrived this month from our California contingent. **Ron Newton** writes, "I've worked for 20 years for Aerojet Liquid Rocket Co., where I manage the Energy Technology Activities. For the past 12 years I've lived in the Sacramento area with wife, Kathy (Simmons and U.C.L.A.), and three sons—John (12), Craig (16), Peter (20). In addition to boy-related activities, we put a lot of our creative energies into working with adults in an educational process to enable individual initiative and responsibility." . . . **Bob Parente** is now the proud father of a third daughter, Jacqueline, who arrived just in time for a 1981 tax deduction. Bob's consulting firm, now in its third successful year, has provided testimony before Public Utility Commissions in seven states, including Pennsylvania and the Three Mile Island event. . . . Classmates visiting the San Francisco area should be sure to pick up a copy of *Family Bike Rides* by **Milton Grossberg**. Published in June 1981, the book is a guide to 40 paved, off-the-road bicycle paths in Northern California.

Next month we'll have more news of classmates who've joined the growing number of authors in the Class of '58.—**Michael E. Brose**, Secretary, 59 Rutland Sq., Boston, MA 02118

62

The National Academy of Engineering has honored **Floyd Dunn** by electing him to membership. Floyd is professor of electrical engineering, bioengineering, and biophysics at the University of Illinois at Urbana-Champaign. He was honored for his contributions to fundamental knowledge of ultrasonic propogation in, and of ultrasonic interaction with, biological media. Even though we are on the same faculty, I was unaware that Floyd was a member of our class. My only excuse is that the university is huge and there are so many M.I.T. alumni here in town, five of whom (at least) are members of our class. . . . **Philip S. Schmidt** was recently promoted to professor of mechanical engineering at the University of Texas at Austin. He will return this fall to full-time teaching and research after sabbatical leave as consultant at Electric Power Research Institute in Palo Alto, Calif. . . . **Rurik B. Halaby** has started his own company specializing in financial consulting and investment banking. He writes that he has recently seen fellow classmates **Bill McFarland**, **Cal Opitz**, and **Doug Cassell** and has spoken to **Larry Turner**. Rurik, along with myself and probably many others, has trouble believing it's been 20 years since our graduation. . . . **Henry McCarl** is now listed in *Who's Who in Engineering* by virtue of his service on the board of directors of the Society of Mining Engineers. He was recently elected president of the Alabama section of the American Institute of Professional Geologists. His recent election to the St. Andrew's Society of the Middle South entitles him to wear the tartan of his Henderson clan ancestors, and he promises to wear his kilts to one of our class reunions.

Robert G. Kurkjian is currently manager of the Autotest Engineering Laboratory at Hughes Aircraft. He recently finished three years as chairman of the IEEE Standard 416, ATLAS committee. ATLAS is a standard, high level programming language for automatic test equipment. . . . **Thomas G. Burns** was recently appointed assistant general manager of the economics staff of Standard Oil Co. of California. . . . A newsclipping announces that **Barry J. Fidelman** has been elected vice-president of marketing and customer services for Apollo Computer, Inc.—**John Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

63

A veritable deluge of class notes this month, so I'll dispense with the chitchat and get right to business. **Tony Geisler** writes that he is still living in Modesto, Calif., where he is executive vice-president of A&W Concentrates. He wants all good alumni to drink A&W Root Beer to keep him off the bread lines. Tony's wife, Dee, keeps busy raising their two daughters, now 9 and 11, and serving on the school board, to which she was re-elected last November. Modesto, Tony informs us, is on the way between San Francisco and Los Angeles, and urges classmates in the area to come and visit. . . . **Ted Cohn** and his wife, Barbara, are the proud parents of a daughter, Adrienne Leah, born last January. . . . **Joel Schindall** tells us that he came to California in 1967 to try living here for a year or two. He's still here and he loves it. (I know the feeling.) Joel works at Watkins-Johnson, where he recently invented a time-domain spectrum analyzer for PRF of pulsed wave forms. He's still doing some teaching—leading an est seminar. Joel and his wife of two years, Alice, recently celebrated the arrival of their first child, Katie Julane. . . . Former class president, **Garry Stone**, joined the venture capital/investment banking firm of Hambrecht and Quist in September 1981. He says that the high technology investment banking business is amazingly fast paced and exciting and that he finds it a thoroughly satisfying and challenging work environment. Garry says that he would be pleased to hear from any classmates with venture plans or investment banking needs where H&Q could help. The firm is located in San Francisco.

Jeff Levinger's technical writing business is thriving, his two year old son, likewise. Jeff is adding four rooms to his house and would like to hear from old friends. . . . **Howard Pielet**, his wife, Barbara, and sons, Yaakov and Eli, celebrated Yaakov's Bar Mitzvah last July at the Kotel (Western Wall) in Jerusalem. Howard says it was an absolutely marvelous experience. The family toured Israel for a month from Banyas to Eilat and visited friends and relatives that they hadn't seen for years. . . . **Thomas Bogan** is still with Alliance Capital analyzing investments in the technology based industries. Tom recently became a senior vice-president. His wife, Beth, teaches at Fairleigh Dickinson University in Madison, N.J. The Bogans have two sons, ages 10 and 7, who ski better than their parents. . . . **H. Roland Zapp** continues teaching at MSU, while his wife, Roberta, (Wellesley, '64), practices internal medicine. The Zapps' oldest child, Alisa, is busy in high school, while son Jon is active in "everything" in middle school . . . **Stan Dunten** has been working at the Kiewit Computation Center at Dartmouth College since 1971 in the field of computer communications. He is currently involved in building a network to service local and remote users. Stan says he enjoys the small college town of Hanover, as well as the challenge of being a single parent of Sean, 11, and Seth, 6. . . . **John Brach** sends greetings from Atlanta. He is still with MARTA, where he is project manager for Transit System Development. He says reaching 40 this year was a real bummer, but he is sure he has lots of company among his classmates. John's children are now 12, 9, and 4, and he is still playing tennis and racquetball to stay slim. . . . I notice that a lot of us are "still" at the same jobs, and "still" doing the same things we have been doing for many years. Are we settling down and mellowing out after all these years?

From the press release department, old and new, we learn that last December **Tom Wojick** was promoted to manager, distribution planning, at Corning Glass Works' medical and scientific division. Tom has been with Corning since 1964. . . . **Jim Evans** presented a paper on "High Resolution Angular Spectrum Estimation Techniques for Improved Angle of Arrival Estimation." This work applies recent advances in real time digital signal processing technology to air traffic control systems. Jim is assistant group leader of the Radar Sensors Group at M.I.T.'s Lincoln Lab. . . . **Steve Kaufman** was appointed group vice-president in charge of brake operations and high temperature thermal systems at Midland Ross Corp. Steve came to Midland Ross in February 1980 as vice-president and general manager of the Midland Brake Division. . . . **John Scott** was elected to the National Academy of Engineering. John is vice-president of process research at Chevron Research in Richmond, Calif. . . . Finally, we had a call recently from **Bjorn Conrad**, who was visiting southern California on business. Bjorn is still with SRI and living in Portola Valley on the San Francisco peninsula. His three daughters have grown up to be three young women.

Well, that's all there is folks. Keep me deluged with notes—I love it. Remember the class reunion next June, our 20th. Plan your vacation around it—your kids will love Boston in the spring.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

65

It's April 4 as I write this column. I know it must be April because my plant closed at noon today to get everyone home in the snow, which I have now shoveled twice off my driveway. I know those of you in California must be missing Cambridge and M.I.T. as you read these lines.

Mark Hanson reports that he ran into **Ed Yourdon** a year ago and has adopted Ed's "structured analysis" concept in his small programming shop. Mark completed the first "structured specification" of his firm's financial systems in February. Mark also says he and Pamela enjoy the monthly open rehearsals at the Boston Symphony. . . . **Homa Lee**, a fellow civil engineer, reports that he is working on the geotechnical engineering aspects of offshore geologic hazards for the U.S. Geological Survey. Homa is also continuing work on his Ph.D. from Scripps Institute of Oceanography. . . . **Rich Amster** says that after consulting for a year and buying a condominium with his POSSLQ (person of opposite sex sharing living quarters) they are leaving Boston for a 17-month round-the-world adventure.

John Golden was recently promoted to director, Information Services, by the vice-president and general manager of Honeywell's Electro-Optics Operations in Lexington, Mass. John says he is responsible for information systems, telecommunications, and office automation services. He also oversees other administrative areas like plant engineering for the facility. John and Carolyn live in West Newton with their four children. John says he is active in youth hockey programs with his two sons. . . . **Bruce Zotter** has been named a partner in the Washington law firm of Finnegan, Henderson, Farabow, Garrett, and Dunner. Bruce joined the firm, which specialized in patent, tradmark, antitrust, and licensing law, after he graduated from George Washington University National Law Center. . . . **Ed Burke**, an old friend and colleague of mine, has been promoted to head of the new Computer and Networking Technology Department at the MITRE Corp. Ed has been at MITRE since he left the University of Pennsylvania in 1971. . . . **Jonathan Lane** is a principal of Lane, Frenchman, and Associates, a Boston architecture and planning firm. Jon reports that the firm received the American Planning Association award for the best project of 1981 for its work on New York State's Urban Cultural Park program and is now redesigning the "D Street" public housing project in South Boston.

Lew Counts spoke on AC measurement and true RMS at a meeting of one of the local IEEE chapters. Lew is manager of linear IC design at Analog Devices Semiconductor in Wilmington, Mass. . . . **Jeff Meldman** has been appointed an associate dean of student affairs with responsibilities focused in the areas of freshman advising and support to undergraduate teaching. Jeff is also an associate professor of management science and chairman of the undergraduate program at the Sloan School. He has a Ph.D. in electrical engineering and computer science from M.I.T. as well as a J.D. from Harvard. . . . **Bob Field** has been promoted to manager of communications systems for the ECI Division of E-Systems in St. Petersburg, Fla.

So that is this column for spring. I hope that by the time I write for fall the snow will at least be melted.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66

This month's mailbag actually contained mail. **Ken Browning** writes describing the joys of renovating old home number three. Ken is now chief financial officer of Illinois Wesleyan University in Bloomington, Ill. . . . Lenore and **Carl Jones** and their two children, Matthew (5) and Karen (2), are enjoying life in the San Francisco area. Carl manages the Software Development Department for Tymshare's Integrated Systems Division. Nory is managing development of on-line library systems for Research Libraries Group at Stanford.

The long distance record for news in this column goes to **Roger Koch**. The postmark is Woomera, South Australia. He is working for Aerojet Electro Systems of Azusa, Calif., who saw fit to transfer him to Woomera. Still single, Roger inquires whether our readership includes eligible women who might enjoy "the cultural advantages of Woomera." . . . **Jack Fuhrer** received the David Sarnoff Award for outstanding technical achievement at RCA. He developed a CCD comb filter integrated circuit for color TV receivers. . . . **Samuel S. Wagstaff, Jr.**, has been appointed associate professor in the Department of Statistics and Computer Science at the University of Georgia. . . . **Terry J. van der Werff** is enjoying his job as dean of science and engineering at Seattle University. Terry, Renee, and their five children had quite a readjustment to make after living in Africa for six years. He reports that the sons of M.I.T. now dominate engineering education in Seattle, as the dean of engineering at the University of Washington (Ray Bowen) is a Tech alumni and fraternity brother of Terry's.

Jonathan Hopkins, wife Peggy, and new daughter Amy live in Kalamazoo, Mich., where he has a practice in neurosurgery. . . . **Everest A. Whited III** has a practice in family medicine in Corpus Christi, Tex. He reports that the children, Jennifer and Phillip, are doing well and that he has visited with **Joel Talley** in Houston. . . . Texas sent its share of news this month. The University of Texas appointed **David O. Wood** to the advisory committee of its Center for Energy Studies. . . . University of Texas at Dallas named **Ronald W. Ward** director of the Center for Lithospheric Studies. His wife Jean has embarked on a new career, owning and running a gift shop.

Heard from my fraternity brother **Pete Cukor**. He is now senior vice-president and director of the Industrial Planning Division of Technekron in Berkeley, Calif. His work involves the application of new technologies to the mining and transportation of coal. . . . **R. Wendell Snyder** has spent the last seven years in the Middle East and is currently managing construction of a power facility for Bechtel in Saudi Arabia. . . . **Michael Ward** is designing instruments for Hewlett-Packard. He pointed out that **Bill Tippett** has been named division manager of H-P's instrument division. . . . **John W. Dawson** was promoted to associate professor of mathematics at Penn State, York Campus. . . . **David P. Vanderscoff** was named chief executive officer of Manhattan National Life Insurance Co. in Bismark, N.D. . . . **Harry S. Cohen** has

been named a vice-president of System Design Concepts of Washington, D.C. and New York. . . . **Harry Moser** was promoted to manager of aftermarket sales and service for Waternol Acme Co. . . . **James A. Lash** is managing partner of James Lash and Co., a consulting firm in Detroit and New York. . . . We were saddened by the loss of a classmate, **Alan H. Cooper** of Bristol, England passed away on October 6, 1981.

The time frame for preparing this column is such that I am supposed to close this time with, "have a nice summer." Well, it's snowing out, and I'm losing the fight with my teenage son over who will shovel the driveway. Have a nice summer anyway.—**Joe Shaffery**, Secretary, 34 Hastings Dr., Fort Salonga, NY 11768

67

Dave Schramm has accepted a three-year second term as chairman of Astronomy and Astrophysics at the University of Chicago. He was awarded the Gravity Foundation Prize for work on a neutrino-dominated universe. . . . **Joe Klawsnik** and Holly Ramsey were married last August and have begun private practice in psychotherapy together. . . . **Rod Peterson** writes that last November, after working in the shipbuilding and aerospace industries in the Tidewater, Va., area for 14 years, he embarked on a new career as a project engineer with Northeast Utilities in Connecticut. Rod, Mary Kay, and their two children, Colin (7) and Marney (5) have moved into their new home in West Hartford and are looking forward to becoming reacquainted with New England. **Dave Dilling** spent four years with Brown and Root in London, working on North Sea oil projects. He is now working for Bechtel, which has loaned him to the Princeton Plasma Lab. . . . In 1979, **Gary Laux** formed his own geological consulting firm, All Terrain GeoScience, after working for several years as a geological scientist in both government and private sectors. Gary is a registered geologist in both California and Oregon. He and his wife have two daughters and a son, and are expecting another baby soon. . . . In March, Sharlotte and I went sailing and had an enjoyable dinner with **Bob Howard** at Boca Raton, Fla. Bob is active in several business ventures, including his consulting firm, Florida Consulting Group.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

69

The first item of business is to announce that our fourth consecutive annual class reunion will be on Saturday, July 31, at the beachside home of Sina and **Tom Najarian** in Hull. Please let Sina (617-925-1667) or me know if you can make it. Sina and Tom have been living in their new solar home for nearly a year, designed by Tom with the help of classmate **Bruce Anderson**'s *The Solar Home Book* and the example of M.I.T.'s Briggs Field Solar Home. . . . **Paul E. Beckerman** is now teaching economics at Fordham University after spending a year under a Fulbright grant in Peru teaching economics and doing research on the Peruvian inflation problem. . . . **Jerry Levinson**'s specialty is aesthetics at the University of Maryland where he is an assistant professor in the Department of Philosophy.

After computer related careers, the medical profession seems most popular for our class. **John M. Brown** has just finished a one-year fellowship in hematopathology at Upstate Medical Center in Syracuse, N.Y., after completing a four-year residency in anatomic and clinical pathology at the University of Minnesota Hospitals. . . . **Joseph A. Horton** left West Virginia University and returned to Presbeterian University Hospital of the University of Pittsburgh where he did his neuroradiology fellowship and is now an associate professor of Radiology in the neuro section. . . . Jodi and **Hank Levine** are happily living in Tulsa, Okla., where Hank's pediatric practice is growing well—as are his orchids, which have acquired eight American Orchid Society awards. He has also been appointed to the advisory board of Childbirth and Family Life, a subsidiary of a national La Maze group.

Having taken the "entrepreneurial plunge," **Chris Brooks** is founder and president of C. W. Brooks Associates, Ltd., which specializes in providing education and consulting services in the area of manufacturing planning and control systems. . . . **Rexford Stark** is self-employed as an antique dealer and publishes several catalogs per year.

Robert Carter Austin is just finishing his eighth season as artistic director and conductor of the Chattanooga Opera in Tennessee and his fourth season in the same post with the Southern Regional Opera of Birmingham, Ala. He has also been appointed music director and conductor of the Cheyenne Symphony Orchestra in Wyoming, and this spring he guest-conducted operas for the Minnesota Opera and the Chicago Opera Theater. . . . Sher and **Rick Barnes** have been active in local theatre in Acton, Mass., most recently as romantic leads in Cole Porter's "Anything Goes." Sher is in the personnel department at Digital; Rick has built his first radar at Sperry. . . . **Monib Khadem** reports that he is now working with Werner Erhard as a trainer. He is conducting EST seminars and workshops in the U.S. and Europe. He is still a bachelor and has started swimming regularly.

Stanley Sramek is working as a geophysicist with Texaco in Houston, Tex. . . . A brief note from **Gregg Dieguez**: he has been put in charge of building Saddlebrook's major new product line of banking systems. . . . **Robert Zimmerman** has been quite busy and says he is "now consultant in biomedical electronics involved with new device development for product research and development. I was with NASA Headquarters as Director of the Biomedical Applications Program and have a flight experiment on the COSMOS Project in the Summer of '82. I am a member of Medical Advisor's Council to the Biomedical Program at Cal Tech's Jet Propulsion Lab and have been appointed chairman of the IEEE Committee on Health Care Technology."

W. David Lee is still a consultant at Arthur D. Little and is still rowing on the Charles River. He saw **Lyle Groome** in Denver, Colo., where Lyle is working at SERI and has started his own microcomputer software company. Lyle continues his marathon chess game with **Smith T. Wood**, who is currently in Washington. . . . The first in our class to retire is **Dick Whitney, Jr.**, who retired from the U.S. Navy last year and has since been working in McLean, Va., for Advanced Technology, Inc. (ADTECH), a professional services firm, where he has been working with the Saudi Naval Expansion Project.

Mike McNutt reports that he has been living in Yorba Linda, Calif., for the last four years, since leaving the University of Illinois as an assistant professor of Electrical Engineering. He is working at Rockwell International in Anaheim and thinks Southern California is great: he's thrown out all his heavy coats and sweaters and he plays golf all year round. . . . Enjoying the Northern California sunshine in Palo Alto is **Tom Stewart**, his wife Martha and son Michael. Tom recently joined the signal processing firm of Argo Systems and is currently learning the "tricks and techniques" of digital signal processing. . . . Nancy and **Benjamen Franklen** have lived for four years in Brussels, Belgium, where Ben is the European technical support manager for Intel Corp. He is currently very involved with building up a software and systems engineer field force for their new systems products.

This just about catches us up on several months of news. Don't forget about our reunion July 31 and I hope to hear from you soon.—**Robert K. Wiener**, Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

71

Dan Weinberg is an economist for the U.S. Department of Health and Human Services in Washington, D.C., and celebrates the birth of his third son, George, on December 8, 1981, who joins Garrett (4) and Henry (3). . . . **William R. Shockley** is a Lieutenant Commander in the Navy and is an instructor of computer science at the naval postgraduate school in Monterey, Calif. . . . **G. Thomas Gibson** was promoted and transfered from the Western Electric Co. in North Andover, Mass., to AT&T General Departments in Murray Hill, N.J. Tom is now a district manager of financial planning, actively involved in the planning for the coming divestiture of the Bell System. . . . **Bryce W. McIntyre, Jr.**, graduated from the Biblical Theological Seminary in May. . . . **Marc H. Alpert** completes his surgical residency at the Metropolitan Hospital Center in New York, N.Y., and starts a fellowship in vascular surgery at the Newark (N.J.) Beth Israel Medical Center.

Donald S. Feith is married, has a daughter (Dina, born April 1981), and has started a small computer company: Feith Systems and Software, Inc. . . . **W. H. Rastetter** is now the director of chemical sciences at Genentech, Inc. . . . **Neal R. Satten** has had his second child, Susanna Cordish Satten—a sister for his son, Matthew. Neal attended the wedding of **Fred Fritman** to Marni and saw ZBT's **Wallin, Cooper, Levinson, Fleishman, Gray** and many others at the wedding. . . . **Leonard Tower, Jr.**, purchased a home in Somerville and vacationed in Europe. He attended *The Tech*'s Centennial Convocation. . . . **John Collier** is currently in Vancouver, B.C., teaching philosophy of science at the University of British Columbia. . . . **Mike Linehan** married Martha Cox (Gordon, '73) in November and was in the Virgin Islands during the December 6 Boston snowstorm. **Ken Weisel** and **Ed Elliot** were at his wedding. Mike and Marty finished a house in Natick, Mass. He is still at Sylvania in Needham, working on fiber optic communications systems.

Alan Jay Smith is a tenured associate professor in the Computer Science Division, Department of Electrical Engineering and Computer Sciences at Berkeley. In addition to his teaching and academic duties, he performs research and consults in computer system performance. . . . **Larry Speck** of Austin received a citation in the 29th annual Progressive Architecture Awards program, for the Bernet (Tex.) Town Center. I have seen a picture of the proposed structure, and it is beautiful. . . . **George W. Scherer** was appointed a research associate in ceramics and exploratory research at Corning Glass Works. . . . I was appointed by the Governor to the board of the Texas Air Control Board, the state agency responsible for enforcing and administering the Clean Air Act.—**Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

73

John Chandler writes about the birth of his first child, Holly Lynn, '03, who lives with them in a 100-year-old house in the suburbs with dog, cat, and 37 house plants. (I know you all are reading my column. Two births announcements this month had graduation years suffixed to their names.) . . . **David Moylan** is chief resident in the Department of Radiation Therapy and Nuclear Medicine at Thomas Jefferson in Philadelphia, Pa. He will stay on there as assistant professor of radiation therapy, doing research on inoperable lung cancer. . . . Fellow doctor **Patrick Marcotte** has moved to Chicagoland as a research chemist at Abbott Labs after three years at Johns Hopkins. . . . Fellow (trial-by-) juryman **David Simen** is now working as an operations planner at Bell Labs in Neptune, N.J., looking for poker and backgammon players.

Allan Spoon, formerly vice-president and partner of the Boston Consulting Group, was elected a vice-president at the *Washington Post*. (Maybe he can get their classified rates back where they were when D.C. was a two-paper town.) . . . Tish and **Scott Davidson** have a daughter Helen, '03, as of December. She is "smart and beautiful" according to proud papa. . . . And yours truly is getting back to work!—**Robert M.O. Sutton, Sr.**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

74

As you scan the Class Notes, a look of amazement crosses your intellectual brow: your column is here, not just a vague memory. So enjoy it—we've got an awful lot of stuff to consume and react to! First the news:

Dennis M. Bachovch has married Sue Govia as of September 5, 1981. I believe that Dennis is still working for Westinghouse in Pittsburgh, Pa. . . . **Larry Eisenberg** writes: "I am still director of budget operations in the Wisconsin State Budget Office. I have been working to bring our office into the 1980s of data processing—personal computers linked into a mainframe. Pretty strange for an Urban Studies undergraduate. My wife, **Chris Eidsor Eisenberg** has been working on the construction and sale of miniature furniture, lighting, and rooms. Chris is quickly building a national reputation for her work. She has done miniature shows around the Midwest and the West Coast. In the fall, she will be heading East. I'm not quite sure this is what her microbiology profs had in mind."

David Mark Schneider was married to Rochelle I. Fogelman on November 8, 1981, at Temple Beth-el in Bethesda, Md. At last report, David was working in the Department of Physics at the University of Maryland in Baltimore. . . . **Carl Howe** is still with Bolt, Beranek, and Newman, Inc., in Cambridge. Carl taught a course called "Introduction to Computation" at Wellesley College last fall.

One of the side benefits of being involved with these notes is reading the crazy messages scribbled on the various donation cards. "The difference between men and boys is the price of their toys"—so writes **Jack Rich**, who has acquired a "shiny brand new Grotrian Concert Grand piano." Play on, Jack. . . . **Thomas E. Wolff** is doing what he terms as "exploratory" plastics research at Amoco Chemical Corp. in Naperville, Ill. His wife, Marcy, is working her way through her first year of a Family Practice residency program. . . . **Marko Slusarczuk** is finishing law school, getting married to Stephanie Wood in September, and then moving to Washington where he will join up with the firm of McKenna, Conner & Cuneo.

Frederick P. Duncanson has completed his medical residency at Mount Sinai Hospital in New York, N.Y., and is now working at New York Medical College at the Westchester County Medical Center, where he is involved with infectious diseases. . . . **Jay Krone** writes that he spent 1981 traveling 62,000 miles for Teradyne in support of sales activities. He remarks that his M.I.T. extracurricular experience served him well in dealing with people in the selling and marketing of high-tech products. . . . **Richard Booth**'s 1981 motorcycle racing career ended in September at Road America with a minor crash and a cracked rib. On the good side, he designed the frame and suspension for the newest Harley-Davidson, which the motorcycling press is calling the first "modern" Harley. . . . **Roger Goldstein** is presently the project architect for a major project at Goody, Clancy & Associates. He has been teaching at the Boston Architectural Center since 1980. He and his wife, Cindy, live in Brookline where they spend all their spare time on their two-family home. Recently, Roger's photographs and Cindy's prints were on display at a show in Louisiana.

Now we get to the Class Business section. Here is advance notice of a few issues which will be covered in future columns: the Class Gift, regional Class Agents, The Alumni Fund, our Tenth Reunion (our what?!), and class president Sandra Yulke. Please send me your updated addresses so we can decide whom to "crash" with when traveling around the country on business.

Back to the trivia. I (**Jim Gokhale**) am still with Index Systems, Inc., in Cambridge, which is in a brand new building across from the F&T Diner. (Does that bring back memories?) I am involved with consulting for Index's clients on new data processing technology. As you can guess, the company is filled with "brass rats."—Co-Secretaries: **Jim Gokhale**, 12 Pond Ln., No. 54, Arlington, MA 02174; **Lionel Goulet**, 34 Tremlett Sq., Dorchester, MA 02124

75

Our thanks and those of the Alumni Fund Office to **Barry Magda**, who was our Class Representative at the last Alumni Fund Upgrading Telethon. . . . **Gray C. Safford** has been working since graduation as a field engineer for the Drever Co. in Huntingdon Valley, Pa. "For the last sixteen months this has required me to live and work in Sault Ste. Marie, Ontario, where I have been involved with an installation of heat treating equipment at Algoma Steel Corp." . . . **Gary Bogossian** says, "I am currently working as a struggling young architect, registered in Pennsylvania."

David I. Katz is still at Burns & McDonnell (A/E) in Kansas City. He is planning an addition to his house to accommodate a new family member due to arrive in May. . . . Last fall, **John Sybalsky** was married to Anne Symanovich (Sloan M.B.A. '77). "Since we lived on opposite coasts, one of us had to move—me, naturally! I am now living in Oakland, Calif., and consulting at Xerox Palo Alto Research Center." . . . **Mark Hurwich** writes, "I am still doing general management consulting at Towers Perrin Forster and Crosby. Recently I have been exposed to a number of interesting situations in high-technology and venture areas; it's very satisfying to bring non-technical skills (like marketing) to these organizations and to improve their viability."

Lydia E. Talmers is "presently back in Boston working at Arthur D. Little and living in Cambridge. Busy at work and training my new dog." . . . **Steven A. Babbus** received a Ph.D. in Astrophysics at Berkeley in September 1981. He is currently a postdoctoral fellow in the physics department at M.I.T. . . . **Wesley Blank** is a second year resident in Obstetrics/Gynecology at North Shore University Hospital, Manhasset, N.Y. He married Nanette Reiner in December 1981. Among those present were **Ron Bich** and **Ken Isaacson**. . . . Speaking of weddings, listen to this from **Janis Weeks**: "Finally some news to contribute to *Tech Review.* I married Bill Roberts (Harvard '70) on March 22 in a (rather unconventional) ceremony performed in the underwater dome at the Seattle Aquarium. The event was timed to coincide with the annual West Coast Nerve Net meetings (an informal aggregate of invertebrate neurobiologists), so many of our out-of-town friends were here. Bill and I are both postdocs at the University of Washington; he is doing muscle membrane biophysics, and I am studying hormonal modulation of neuronal function. We both love Seattle and wish we could stay here permanently, but that's not the way research works any more, unfortunately."

Luther Goodie is currently the information systems planning manager for Analog Devices, Inc. . . . **Ken Deemer** left his position as product line manager of Data Systems Design in San Jose, Calif., to join First Interstate Capital of Los Angeles. The firm is a venture capital company specializing in investments to start up high technology companies. . . . **Scott P. Fulton** is manager of separations technology at Amicon Corp., Danvers, Mass. He got married on May 1 to Elizabeth James of Boston. . . . **David Wargo** is still a security analyst at State Street Research and Management Co. in Boston. He now covers the newspaper, printing and publishing, cable TV, business service and electrical equipment industries.—**Alex Castaldo,** Secretary, 929 Mass. Ave. (12D), Cambridge, MA 02139

76

We have a significant quantity of mail, for which your secretary is thankful. First of all, a letter from **Robert Struth, Jr.**: "I've been wanting to hear from some of my Aero and Astro and NROTC friends that I have lost track of. I spent seven and a half months in the Indian Ocean last year aboard the U.S.S. America, where I flew the F-14 Tomcat fighter as a radar interceptor officer. My wife and I moved from San Diego to Lexington Park, Md., last November. I am attending the U.S. Naval Test Pilot School here. When I graduate in December we'll be moving to Oxnard, Calif., where I'll be a test flight officer at the Pacific Missile Test Center. I have a two-week break in July and we hope to visit Tech and see the sights around Boston. My wife, Donna, loves to travel. She came to visit me in Singapore when the carrier was in port for six days. We spent a total of 17 days in port out of the seven-and-a-half month cruise! We did traverse the Suez Canal twice, which was very interesting. And after each 45-day at-sea period, the Navy saw fit to give us two Miller beers (big deal)." . . . Also from the military, **Timothy Allen** writes, "Returned to Boston area from five-month stay at Fort Sill, Okla., where I graduated with top honors in Army Officers School. Back with Computer Corp. of America in Tech Square, across from M.I.T." . . . And last but not least from the military, **Richard Lopicolo**: "I have not written in a while, so I have some catching up—during the summer of 1980, I was deployed in the North Atlantic on U.S.S. Silversides. Upon returning to Norfolk at the end of September 1980, I was sent to a sonar school at the sub base in New London. I drove up to Cambridge for two of the weekends I was in New England. It was quite refreshing to see Tech again, and I had a good time doing some carousing with **Steve Felsher.** Until August 1981 I was quite involved with the ship. All of our training, repair periods, and short cruises were aimed toward priming the ship for our recently completed deployment. Unfortunately, my time was so occupied (becoming a department head as ship's weapons officer did not make room for play) that I could not make it to the reunion. About the deployment: we were gone for three months, from early September to early December, and we spent two of those three months under the Arctic ice pack, surfacing the boat several times through the ice. The most dramatic was coming up through the ice at the North Pole in October. Port visits included Bergen, Norway; Halifax, Nova Scotia; and Faslane, Scotland. Though in a previous letter I said it looked as if I'd stay in for a career, I've since changed my mind. I've spent too much time at sea in the past three years. In July, I submitted my letter of resignation, and I'll be leaving the Navy in March 1982. With a B.S. in Physics from the 'Tute and a Navy Nuclear Submarine background, I'm not fretting about job hunting."

Bill Grace has sent a cryptic note: "Busy seeking rocks as big as diamonds." . . . **Stephanie Orellana** is "presently a first year Ph.D. student in the Physiology/Pharmacology Department at U.C.S.D., and would love to hear from alumni in the area!" . . . **Patricia Schettig** is "working as a wildlife biologist for the U.S. Fish and Wildlife Service in the mountains of West Virginia." . . . **Jill Kurfirst** reports that she is "working as a project architect for Hellmuth, Obata and Kassalbaum for the last two years. Married Howard Meeks, A.I.A., on January 16, 1982." . . . **Neil Rasmussen** has been appointed vice-president of American Power Conversion Corp. of Burlington, Mass. They are manufacturers of electronic equipment. . . . **Tom Downey** is "currently employed at Ztel, Inc., in Andover, Mass., doing software for a voice/data PBX. Just bought a house in Brighton, built in 1900." . . . **Kirk Blunck** has been named an associate of the firm Brooks, Borg and Skiles, Architects and Engineers, as of January 1, 1982. . . . **Jonathan Lettvin** sends word that he is "currently an employee of Bell Labs at Murray Hill, N.J. Any others there are welcome to contact me in Group 4519."

Michael Rucker is now "settled in Phoenix, Ariz., and pleasantly employed in a consulting firm, doing all sorts of esoteric things. Found a good classical singing group and am busy in local Boy Scouts." . . . From **Neal Macklin**: "I left M.I.T.—and my major—in 1976, and with no computer experience joined IBM. The only other alumnus I ran into there was Rodney Maxwell, '75 (he was actually the 6-3 major), at VM/370 conference. VM took me in 1980 to Amdahl Corp., where I am now a product manager for our high-performance communications processor. There are quite a few M.I.T.ers here! Work at Amdahl is fast-paced and challenging." . . . In other news, I heard through the grapevine that **Alan Dublin** is

now a sanitation engineer for the City of New York. . . . Word from Helene and **Ken Virgile**: "Ken is still enjoying his job in software at Datasphere. Helene will be graduating from Boston College School of Social Work in May and will begin the difficult search for work in that ever-shrinking field. Both are looking forward to their first relaxing summer in years."

Notes on the corporate scene from **Albert Oliver**: "I can't believe that I've been back in New England for almost four years now. I'm still living in Wellesley, and am now working as a registered architect for the Boston office of Skidmore, Owings and Merrill (the folks who brought you the Ritz addition, the Sears tower, etc.). It's just too pinstripe suit to be true...very corporate! I can't wait to move back to California (just kidding)." . . . **Stephen McConnel** sends us word that he completed his Ph.D. in Electrical Engineering at Carnegie-Mellon University in June 1981. His thesis title was, "Analysis and Modeling of Transient Errors In Digital Computers." He also "maintained legal residence in Idaho while working this year as a visiting assistant professor of electrical engineering at Georgia Tech (Athens, Ga.)—can't escape the big city." . . . From **Mike Catrera** and Terri Alterici: "We both attended grad school at the University of Oregon. On March 29, 1980, we became the parents of identical triplet boys—Peter, Gregory and Jason. Mike taught then at the University of Wisconsin, and now works for American McGraw Laboratories, in Irvine, Calif., as a research scientist. . . . **Dave Thompson** is special assistant to the president, Missile Systems Group of Hughes Aircraft Co. Dave holds an M.B.A. from Harvard and an M.S. from Caltech. Previously, Dave held engineering, management and consulting positions with Rockwell International, TRW, NASA, and Draper Laboratory. He was recently awarded the Space Foundation's 1981 National Prize for studies of business strategy for space-based enterprises. . . . Just before these notes were due, I received a call on my answering machine from **Dan Dershowitz** and Debbi Gross, '78. They are back from the Orient and are both working for Halcon International, the chemical engineering consulting firm, and are living in Tarrytown, N.Y.

Your secretary, as usual, is having fun trading. As these notes are due, we are in the midst of British/Argentine Crisis. Such events, of course, create exciting trading in gold, sterling, and soy beans. And we continue to have fun in Swiss Francs, U.S. Bonds, Treasury Bills, and heating oil. This business is not for the nervous. Merrill Lynch has moved its research department (and me) to 2 Broadway, 3rd Floor, New York, NY 10004, (212) 709-2198. Please do feel free to look me up or call after 3:00.—Arthur J. Carp, Secretary, 15 Jones St., Apt. 3D, New York, NY 10014

77

Many thanks to all who sent mail for these notes; we have lots of news from all over. . . . **Gerald Tourgee** is now working as an engineer for Portland General Electric, "trying to keep Trojan up and running." Portland, where? Tell us more! . . . **Steven Oblath** graduated with a Ph.D. in chemistry from the University of California at Berkeley in December and is now working for duPont's Savannah River Lab in South Carolina. Steve also mentioned that **Victor Knapp** graduated from the University of Pennsylvania medical school, **Derrick Arnell** is living and working in Madison, Wis., and **John Lampe** was still in grad school at Berkeley when Steve left. . . . **William Morris** married Paula Canelos and is working for Richard Claybour Associates, Architects, in St. Louis, Mo. William is planning to leave for Athens, Greece this fall to spend a year working and traveling. . . . **Steven Bader** has completed one year of dental residency at Beth Israel Hospital in New York City, after graduating from Harvard School of Dental Medicine. Steve is hoping to return to Boston to practice this July. . . . **Michael Cady** extends an invitation to his East Campus buddies to gather for a weekend frolic at his summer cottage in Rye, N.H., at the seashore. Michael wants to know: "**Steve Holmes**, where are you?" . . . **Libby Cone** is in the middle of a one-year fellowship at the University of Massachusetts medical school. She expects to graduate in 1984 and plans to practice internal or family medicine, with a special interest in occupational disease. . . . **Douglas Currie, Jr.** is now employed at Gould, Inc., as director of product development for their factory automation division. Other employees of Gould include: Dave Agans '76, Jerry Dwyer '81, and Jim Campbell '80.

Harish Dadoo has just returned from Stanford Business School, where he, **Enrique Zambrano**, and Armando Garza Sada, '78, graduated in June 1981. Harish is now working in Mexico City for Casa De Bolsa "Multivalores," an investment bank, as vice-president for corporate finance. . . . **Robert Holzwasser** married Jodie Barnett (Simmons) on November 22, 1981, and is living in Sudbury, Mass. . . . **Brian Hughes** has been promoted to executive vice-president at Corroon and Black/Inspace, a firm which specializes in the insurance of commercial satellites, also some of the astronauts on the Space Shuttle Columbia. Brian married Lissa Martinez, '76, on March 29, 1980. . . . **Jerry Landau** is now working in a two-person engineering department of a refinery in Warren, Pa., and therefore getting to do everything from simulations and design to start-up—"never a dull moment." Otherwise, Jerry spends his time bicycling, hiking, running, and skiing the hills of Pennsylvania. (By the way, Jerry is looking for some chemical engineers to join him.) . . . **Brian Raila** is currently vice-president and co-owner of CAM Productions, Inc., based in Cambridge, Mass., which produces video programs of interest to hotel guests. CAM was recently commissioned to do a short movie entitled, "For Children, About Adults."

Richard W. Reimer graduated with his M.D. from SUNY Downstate Medical Center in June 1981 and is now interning at Mount Zion Hospital in San Francisco. . . . **Stewart Landers** expects to have graduated from Harvard Law School by this June—anyone need a lawyer? . . . **James Richards III** is now the father of three children and the president of a year-old research and development electronics company, Vermont Microsystems, Inc. . . . A long note from **Chuck McGinn**: he will have completed his Ph.D. in physical ecology in June from the University of California at Davis and has already designed and built several passive solar homes. "Rupert (the wonder dog) is slowing down a bit with age (8-and-a-half), but still manages an occasional night out. (As should we all!)" . . . **Richard Smiley** received his Ph.D. in chemistry from Columbia in May 1981, and is now in the two-year Ph.D. to M.D. program at the University of Miami. Richard comments, "The weather is nice when I get a chance to see it...it's only for two years." . . . **James A. Torma** spent two and a half years as a plant engineer for Celanese Chemical Co., in Bishop, Tex., and is now working as a research engineer with Southwest Research in San Antonio, Tex. James is in the data systems department working with controls, robotics, and machine design. . . . **Norman Proctor**, having worked for a few years, is now studying computer science at Columbia, working towards his master's degree.

Robert Cherry wrote a nice, long letter—we'll hit the highlights. Robert will marry Anita Doran (Georgia Tech, '80) on May 16, 1982, whom he met through fraternity brother Steve Mickel, '80. Robert has recently visited Japan, is president of the homeowners association of his condominium, where he has developed a "decent working relationship with the developer" who sometimes works in "true robber-baron style," and is about to become a landlord himself. Robert also manages to squeeze in time to work as an educational counselor and to do some outside consulting with William Hurst, '28 and Sam Denard, '74. . . . I am saddened to report the death of a classmate, **Andrew J. Tobish**, on March 6, 1981. . . . That's all the news this month. Have a good summer, and thank you for writing.—**Barbara Ann Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

79

Howdy, classmates! As I type this, it's April but the weathermen are predicting snow for tonight! It's hard to believe that when you read this it will be summer—as a matter of fact, it's hard to believe that it will *ever* be summer. Oh, well. Happy July 4th to all!

Steve Abrams will be graduating in June (which was last month to you folks) from Ohio State University College of Medicine and will be an intern at Children's Hospital of Akron starting in July. Says Steve, "The three-year medical school program was tough. I'm glad I'm through it and on my way to doing what I want—taking care of kids." . . . **Cathy Miner** has been living in Eugene, Ore., since August of 1981, working as a project engineer in the wood products division of Weyerhaeuser in Springfield, Ore. . . . **Janet Metsa** is with Eastman Kodak in Rochester, N.Y. . . . **Robert Hone** is working for duPont as a development engineer at a plant outside of New Orleans. "Southern living and Mardi Gras are keeping me happy," he reports. . . . **Elaine Sears** says hello and Happy New Year to all '79 classmates! (She's even more confused about what month it is than I am!) . . . **Ed Hunter** is "still at BBN and hanging out at M.I.T."

An update from **Ed Tarney**: "Have gotten involved in real estate on the side—formed a small development firm with my roommate. We buy, improve, and resell resort property, particularly around the Finger Lakes region. Currently living in an attic apartment barely big enough for the hammock. Not anticipating my second million by 1990 anymore!" . . . Congratulations to **Kyung-Sup Lee**, who had a baby girl named Myung-Huyn on July 20, 1981! . . . **Albin Nowitzky** says, "Still working at Informatics, still taking dancing, still diabetic, and still living at my parents' house. I'd like to make Pete, Armand, and Dan Spool famous by mentioning their names. ƆƆƆHIƆƆƆ." . . . **Kenneth Murphy** is finishing up his third year at St. Louis University School of Medicine.

Meanwhile, out in the Sunshine State, **Craig Monsell** is on an "educational leave of absence to attend the M.B.A. program at the University of California at Berkeley. The program is great (faculty, courses, and students) and I'm enjoying it. My wife Betsey (Wellesley, '77) is a staff accountant for Price Waterhouse. For some reason, we get more visitors in San Francisco than we did in Horseheads, N.Y.! Among the visitors so far are Mike Atlas, '77, and wife Linda (nee Meadows), Mauri Rosenthal, '76, Eric Carr, '78 (who has just moved to the West Coast), **Gary Ashley**, and **Juan Fernandez**. . . . **Sandra Viarengo** is still in Santa Clara working for Intel Corp. She will be vacationing in Hawaii for Thanksgiving, and in Florida and Venezuela for Christmas. . . . **Robert Mandel** is finishing his third year of medical school at UCLA. Writes Robert, "At last I am actually working in the hospital, helping with some surgery. I am currently dating an ex-stripper with a master's in mathematics. She is now a third-year law student at UCLA, and can tolerate my busy schedule." . . . **Ronald Newman** is working in El Segundo ("a dingy suburb of Los Angeles") for Xerox Corp. Office Products. Ron claims he is "still dabbling in left-wing politics while living in the People's Republic of Santa Monica!"

Kelly Gamble has been working as an exploration geologist for Gulf Oil in Houston since graduation. Kelly writes, "Although Houston leaves a bit to be desired, the job has been great! This summer I'm marrying Peter Hartshorn, a fellow geologist at Gulf (Penn State, '77). We're hoping to be transferred to one of Gulf's foreign offices within the next few years." . . . **Dave Westenberg** is finishing his second year at Harvard Law School and plans to work in Boston. On March 27, 1982, Dave married Nancy Gooden (Wellesley, '80) at Harvard Memorial Church in Harvard Yard, and at press time was planning a honeymoon in St. Maarten. Congratulations! . . . **Daniel Jaffe** spent the summer of '78 climbing the French Alps, then moved away from the East Coast for the first time to start graduate school at Western Washington Universi-

ty in environmental chemistry. By the fall, he expects to be teaching high school in Washington State. He is residing in Bellingham, Wash.

Robert Light is back in his native Devenport, Iowa, working as an engineer at the John Deere Technical Center, mainly on computer-aided design research and computer graphics. Bob gets together frequently with fraternity brother **Ron Parton**, who is back in his native Iowa City finishing his third year at University of Iowa School of Medicine. Bob warns all of his friends back in the Hub that he plans to be out in the Boston area for extended periods while doing some consulting. (Hi, Bob! HI, Ron!) . . . **Gerald Mata** is employed by Boston Edison Co. as an engineer in the Power Supply Administration Department."My particular responsibilities include the coordination and scheduling of various power system construction projects using computer-based critical path method techniques." . . . **Mike Patrick** writes, "I am specifying requirements for single chip microcomputers for Texas Instruments in semi-tropical Houston, Tex. My only problem is the expense of maintaining a relationship with Diane Gorczyca, '80, who is suffering the rigors and trials of med school in Albany, N.Y."

My colleague from the Class of '80, Ken Turkewitz, swapped some dirt with me lately—in other words, he ratted on all his friends! Here goes. . . . **Dave Winikoff** lives in Sunnyvale, Calif., and works for Rolm. . . . **Scott Macfarlan** left Peat Marwick Mitchell for a place in Harvard Business School's Class of '83. He resides in a condominium in Brookline. . . . **Clay Funkhouser** graduated Northwestern's b-school and lives with wife Jan (an IBM employee) in a house in Connecticut. . . . **Doug Williams** works on chips at DEC, and is also working on a master's in electrical engineering at the 'Tute. . . . **Chuck Harm** lives in Jersey City and plies his trade at Bell Labs in Murray Hill, N.J. . . . **Brian Morse** works for Hughes Aircraft in the Los Angeles area. . . . **Wes Harper** promised to write me himself rather than be misquoted by Ken. (Okay, Wes, now it's practically a written contract—don't disappoint hundreds of readers.) . . . Thanks, Ken, for being such a good spy!

Jim Thompson called recently to let me know that he has moved to the Big Apple. He is living in Long Island City, just over the Queensborough bridge from Manhattan, since last September (despite the name, L.I.C. is really in Queens). Jim is employed as an architect for a firm called HLW. He had been living in Pittsburgh and is halfway through a master's program in Architecture at Carnegie-Mellon University. . . . Another architect, Don Williams, has been here in New York since graduation working for Goshow Associates as an associate. Don is currently applying to grad schools, but isn't sure if he'll go back since his job is going so well. . . . My good buddy Caren Penso, '77, phoned the other day and reported that ocean engineer **Audrey Greenhill** has left Naval Sea Systems Command in D.C. and is now at Bath Iron Works in Maine. Also up in Maine is Audrey's fiancé **Paul Lones**.

Listen, folks—I am always surprised to see just how few people bother to write or call me. Be truthful: is this column the first thing you look at when you get your copy of *Tech Review*? (It's the first thing *I* look at!) Now think of your friends—don't you think they would get a real kick out of seeing the name of someone they know? While you're thinking of it, sit down *right now* and drop me a line—a postcard is quite sufficient. Hope to hear from all of you by the next issue—**Sharon Lowenheim**, Secretary, 131 E. 83 St., Apt. 2G, New York NY 10028

80

Quite a bit of mail came in this month to the Alumni Office—"Who are those guys?"—(the Sundance Kid)—if you don't know, look 'em up in your F.P.B. . . . I always get a kick out of the people who write in with a nice explanation of what they are doing, but don't say where they are. For example, **Andrew V. Baird**: "Present position: ocean engineering at ARCTEC, Inc., a consulting company specializing in arctic technology. Current projects include preliminary design of ice-braking super tanker." I have a sneaking suspicion that he's not in the equatorial region. I also wonder about those who are sure to let you know where their friends are. . . . From **Randy Ross**: "I am living off of my unemployment checks and rewriting a 300-page novel which I finished last June. My friend **Tom Fletcher** is pacifying the natives in Korea." . . . Also abroad is **Linda Morris**, who is a Peace Corps volunteer on Fiji Island. She is serving as head of the mathematics and physics department and teaching as well. . . . **Art Aaron** and his wife Patti are thriving in the southern Bavaria region of West Germany. He is a liaison officer for a German-funded expansion of the U.S. Army hospital there. M.I.T. grads visiting Europe: feel free to call or stop by the Aarons'. . . . On the domestic front are **Steve Neustein** and **Mary Sheffield**, both in their second year at Columbia University medical school. . . . **Peter Reilly** reports that he is working on oil shale and tar sand development in Mobil Research and Development Corp.'s Synthetic Fuels Division, N.J. . . . **Benjamin Teno** is designing parts for sonobuoys at the Raytheon Submarine Signal Division in Portsmouth, R.I. It seems Mr. Teno has gotten involved in some Newport real estate, remodeling a three-family house.

Brian Clouse is in Princeton, N.J. with Ingersoll-Rand Research doing product development engineering for heavy machinery. . . . **David Gravens**: "I am presently living in Newton Highlands, Mass., and working for Xerox /AvtEx systems, completing a front-end communications processor developed on Tandem's nonstop computer for a trading information system." . . . **Theresa Ravese** reports that after a successful completion of a Northwestern M.B.A., she is joining Pepsico as a financial planner in Westchester County, N.Y. . . . **Lissa Martinez** writes, "I have been doing marine/environmental engineering on a free-lance basis in the D.C. area. And I'm finally getting around to taking the E.I.T. exam...and of course I'm still madly in love with Brian Hughes, '77." (Honestly, dear, we try not to be a forum for these things, but we just couldn't resist this one.) . . . Winner of this month's he-must-be-up-to-his-ears-in-hock-for-that-rock contest is **Tabetha Frey**, planning a March 1983 wedding with Lee McCartney, a fellow Garden City, L.I. resident. Congratulations and best wishes. . . . Moving now to the Midwest, **Wes Asbury** (Oak Ridge National Lab) would like to remind you all that there is indeed a world's fair in Knoxville this year. Be sure to drop by.

Martha Buck Griep and husband Jonathan ('81) have moved from Austin, Tex., to Minneapolis, Minn., and are thoroughly enjoying their new positions as engineers for Honeywell. . . . CALIFORNIA: **Mark Mooradian** is with Hughes Aircraft in El Segundo, enjoying the weather, but finding it difficult to play ice hockey. (Mark, dump the puck and get a surfboard.) . . . **Fred Shecter**, with Rockwell International, in addition to sending some of his work via space Shuttle No. 3, sends his regards to the M.I.T. Rocket Society and has started his own in L.A. Fred has also found Hollywood—look for some of his short comedy films on ABC's "Fridays" this fall. . . . **Martin Patin** is a structural engineer with Bechtel Power Corp. in San Francisco and is residing in San Leandro. . . . **Seth Alford** "is still working for H.P., taking square dance lessons, bicycling, photography."

Ed Chang writes in direct from Berkeley; he has passed in and out of several teaching jobs in the Bay Area. . . . **Bruce McIntyre** maintains sanity by riding his motorcycle, while earning an honest living at Megatest in Santa Clara, designing high-speed linear amplifiers for magnetic bubble memory test systems. . . . This writer recently traveled to Oregon State University and presented lectures to mechanical engineering classes on lubricant additive technology for internal combustion engines. While there, I had a chance to meet Professor Wicks, of the Welty, Wicks, and Wilson 10.301/2 textbook. Earlier this year, through the local M.I.T. Club, I ran an alumni dinner with Dr. and Mrs. Gray as guests. Am enjoying San Francisco through the eyes of an 11-year-old, recently acquired through the Big Sister program here. . . . Time slips by like a fieldmouse not shaking the grass. . . . Keep in touch.—**Debra A. Utko**, Assistant Secretary, 1730 Sacramento, No. 8, San Francisco, CA 94109, (415) 771-1490

81

Local headlines were recently made by classmates **David Kane** and **Victor Zaderej** who found themselves in the role of lifesavers after a recent scuba dive off Marblehead, Mass. Kane and Zadarej had decided to stop diving for the day because of increasingly poor weather conditions, when two people arrived for a dive. "They seemed inexperienced," Zaderej says, "and we advised them against diving since fog was rolling in and there was no visibility. We were almost ready to leave when we heard the man yelling. The woman was out of sight. We ran out, and she must have dropped her weight belt, because she bobbed up to the surface. She had stopped breathing when we pulled her in, so we gave her mouth-to-mouth resuscitation. By the time the ambulance came, she was breathing again." The woman recovered quickly and returned to her home after the experience.

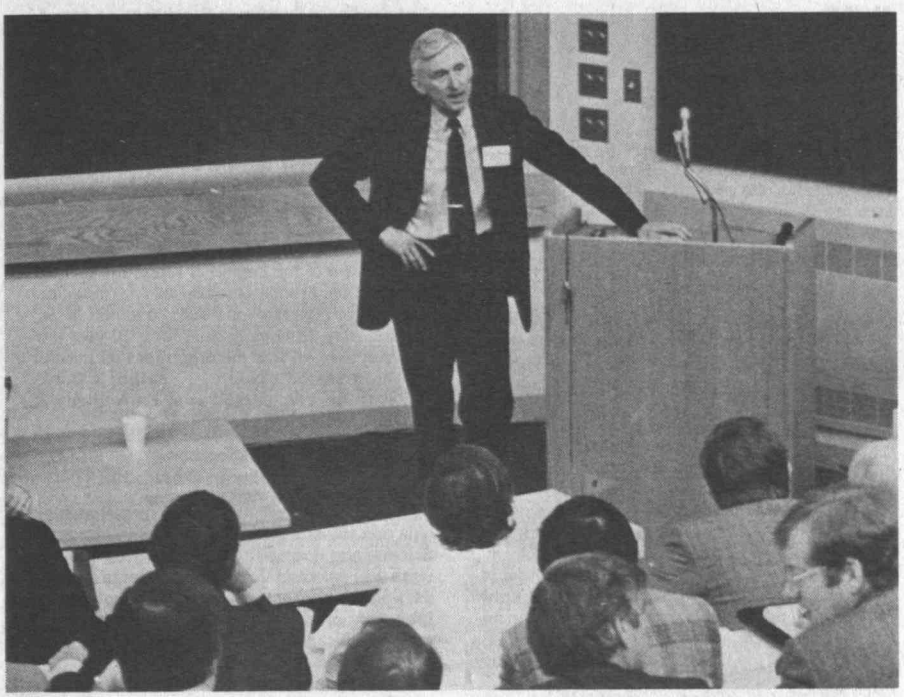
Linus Yamane sent me another letter from Yale Graduate School. Linus seems destined to become an Assistant Class Secretary, for the news he sends is the equivalent of any recent column: "**John Benson** has been ripping apart the ice hockey rinks in Rochester, N.Y., and spends his spare time working as an engineer for Eastman Kodak. Maybe John has learned how to take photographs now, though he never had trouble getting into them. . . . **Yong Fatt Choong** has been working for the Marine Outboard Motor Corp. since July, and has already toured most of the globe making plant inspections. . . . **Alex Hamza**, **Mark Perkins** and **James Theiler** are all in graduate school at Stanford. Alex is in Chemical Engineering, while Mark and James are in Operations Research and Applied Physics, respectively. . . . **Josip Loncaric** is supposed to be doing graduate work in Applied Math at 'Hahvahd,' but he was last seen riding his bicycle from Cambridge to New Haven. . . . **Harsha Jayawickrama** is enjoying his work at Sraffa Technologies in New York." (Thanks for playing Class Secretary *pro tempore*, Linus.)

John G. Mulligan is quickly climbing the ladder of success: he was recently appointed Northeast Regional Postmaster General by the U.S. Postal Service. (Now you know whom to call if your copy of *Technology Review* comes late.) . . . Going from the petty politics of M.I.T. student government to the even more petty politics of Boston city government is classmate **Walter Crosby**. Walt, who had an outstanding tenure as U.A. Finance Board chairman and Football Club co-captain while at M.I.T., is now informations system director for the City of Boston's Office of Property Equalization, which is under court order to revaluate all Boston property to full market levels. . . . Our class has established at least one outpost in Harvard Square: classmates **George Dowd**, **George Noll** and **Dale Zimmerman** (all from Lambda Chi Alpha) are currently sharing an apartment there. George Dowd is employed with Industrial Economics, Inc., in Harvard Square. . . . **Grant Harris** writes that he's gone to the Caribbean for a month, and he plans to start an energy and automation consulting business this summer.

Jonathan M. Danner is currently a navigator (2nd Lt.) in the Air Force and is stationed at Pease Air Force Base, N.H. . . . **Harvey Woehlck** is attending Dartmouth Medical School. . . . **Jonah Garbus** is "writing a novel about trillions of people living in Space Colonies in the year 2400." . . . **Carol Julin** is working at the Cleveland Clinic doing research in orthopedics.

Finally, **Stuart Anderson** puts it well, stating simply, "I'm just a happy kind of guy." . . . Until next month, keep those cards and letters comin'.—**Chuck Markham**, Secretary, 532 Beacon St., Boston, MA 02215

Courses



A large audience for the Materials Processing Center/Industry Collegium spring workshop. In addition to Professor Merton C. Flemings, '51 (left), who directs the collegium, speakers included Professors Lester C. Thurow of the Sloan School of Management (on the role of technology in increasing the nation's productivity) and Myron Tribus of the School of Engineering (on issues relating to engineering and corporate management) and several members of the department of Materials Science and Engineering. (Photo: Calvin Campbell)

I
Civil Engineering

Professor **Rafael L. Bras,** '72, who is Gilbert W. Winslow Associate Professor at M.I.T., will be on leave next year with a Guggenheim Fellowship; his proposal was for research on similarity, scale, and order in hydrologic processes.

Promotions effective in July include those of **Herbert E. Einstein** and **Nigel H.M. Wilson,** Ph.D.'70, to full professor, and **Michael N. Fardis,** Ph.D.'79, **Harold F. Hemond,** Ph.D.'77, and **Michael D. Meyer,** Ph.D.'78, to associate professor. . . . Professor Einstein, whose background is in rock mechanics and geology, is a member of the Geotechnical Group of the department, and his major work is in tunneling technology. He was trained at the Eidgenossische Technische Hochschule in Zurich and came to the U.S.—and to M.I.T.—in 1966. . . . Professor Wilson, a native of England and a graduate of Imperial College, London, is a specialist in transportation systems analysis as applied to urban areas—including paratransit as well as more conventional mass transit forms. . . . Professor Fardis, a native of Greece, holds degrees in nuclear as well as civil engineering, and his special field is the mechanical behavior of construction materials and structural reliability. . . . The ecology and hydrology of coastal wetlands, bogs, and lakes are the special fields of Professor Hemond—including especially biogeochemistry and the recycling of natural minerals through aquatic environments. . . . Professor Meyer's specialty is the links between urban politics, transportation systems, and transport innovations in urban transit.

Jekabs P. Vittands, S.M.'67, has been named senior vice-president of Metcalf & Eddy, Inc., Boston, Mass. . . . **Steve H. Blair,** S.M.'74, has been named a senior hydrologist in the office of Dames & Moore, Phoenix, Ariz.

II
Mechanical Engineering

William C. Unkel has been promoted to the rank of associate professor in the department, effective July 1. He holds degrees from Clarkson and Stanford, and he joined the faculty upon completing his doctorate in 1977. Since then he has made important contributions to the field of magnetohydrodynamic power generation, and he's now working on the applications of electrical discharges in mechanical systems such as i-c engines and arc welding.

Associate Professor David C. Gossard won the Society of Manufacturing Engineers' 1982 Outstanding Young Manufacturing Engineer Award; he was cited for "technical contributions to the manufacturing engineering profession and for furthering the society's purpose of advancing scientific knowledge."

John Klein, S.M.'69, has been promoted to manager of research and development for the Metco Division of Perkin Elmer Corp. . . . **John A. Clark,** Sc.D.'53, writes, "In my 25th year as professor of mechanical engineering at the University of Michigan, Ann Arbor. Served two years (1978-80) as president of the Central Solar Energy Research Corp., Detroit, Mich. Received ASME Centennial Medallion (1981) and the Heat Transfer Division Memorial Award (1978). Recently completed a survey of the U.S. solar industry for the Department of Energy as part of a 12-member solar technology assessment panel.

III
Materials Science and Engineering

Professor **Walter S. Owen,** who has been head of the department since 1973, will leave that post on September 1, and a search committee for his successor as department head has been organized under the chairmanship of Professor Ronald M. Latanision. Professor Owen will return to teaching and research in physical metallurgy, the field in which he was engaged at the University of Liverpool before coming to the U.S. in 1966.

Professor **Donald R. Sadoway,** who directs a research program in the development of modern extraction metallurgy by electrolytic processes, has been promoted to associate professor in the department, effective July 1. He came to M.I.T. in 1978 following completion of graduate study at the University of Toronto.

Robert G. Block, S.M.'69, has been appointed

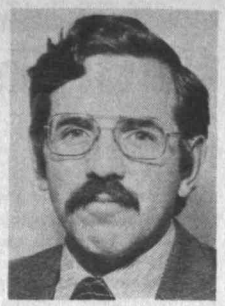
H.H. Einstein

Nigel H.M. Wilson

R.E. Cohen

R.W. Field

D.P. Bertsekas



C.G. Fonstad

manager—sales and engineering, ophthalmic products, Technical Products Division of Corning Glass Works, Corning, N.Y. . . . **Charles W. Finn,** Ph.D.'71, reports, "I have just spent six months back at M.I.T. as a visiting scientist working with Professor **John F. Elliott,** Sc.D.'49, on the fast fluid bed reactor. I worked with two graduate students and a UROP undergraduate student. The project went well and the results were presented at the AIME annual meeting in Dallas last February. It was a pleasure returning to M.I.T. after 11 years overseas."

IV
Architecture

Richard Leacock, professor of cinema at M.I.T., will teach a workshop on independent film/video production during the 12th annual Summer Institute for Media Arts at Endicott College, Beverly, Mass., from July 11 through 25. . . . **Stephen A. Kliment,** '53, senior editor at the Whitney Library of Design, is coordinator of a one-week course in promotional tools and tactics for architectural offices to be given in the Continuing Education Program of the Harvard Graduate School of Design from July 12 through 16.

James Andrew Carr, M.A.A.'72, reports that he is director of design at J. Gordon Carr and Associates, Architects, New York City, specializing in corporate interior work and life cycle costing.

V
Chemistry

Robert W. Field, who joined the department as assistant professor in 1974 after graduate study at Harvard and postdoctoral work at the University of California in Santa Barbara, has been promoted to the rank of full professor, effective July 1. Professor Field has pioneered in the application of laser spectroscopic techniques to diatomic molecules and polyatomic species, and he's played a key role in establishing a tuneable laser spectroscopy facility within the M.I.T. Spectroscopy Laboratory.

John D. Roberts, who taught chemistry at M.I.T. from 1946 until 1953 when he went to Caltech to become professor of organic chemistry, was honored last spring with the 1982 Theodore William Richards Medal for "conspicuous achievement in chemistry" of the Northeastern Section of the American Chemical Society. Dr. Roberts is now Caltech's vice-president, provost, and dean of the faculty.

Donald R. Wiles, Ph.D.'58, reports that he is continuing as a radiochemist working on analytical problems of radium and thorium. Currently (1979-85) he is chairman of the Chemistry Department at Carleton University, Ottawa, Canada. His major recreation is a beef cattle farm operated with his wife Billy, a former secretary in soil mechanics.

VI
Electrical Engineering and Computer Science

Six members of the department faculty have been promoted, effective July 1—three to full professor, three to associate professor. The new full professors are **Dimitri P. Bertsekas,** Ph.D.'71, **Clifton G. Fonstad,** Ph.D.'70, and **Patrick H. Winston,** '65; the new associate professors are **Arvind** (that is his only name), **Pierre A. Humblet,** Ph.D.'78, and **Jae S. Lim,** '74.

Professor Bertsekas' specialty is optimization theory, which he has applied to digital data networks since joining the faculty in 1979. Following his graduate study at the Institute, Professor Bertsekas taught at Stanford and the University of Illinois. . . . Professor Fonstad combines skills in semiconductor materials technology and electronic device design, and as a result he has contributed a number of practical new systems for performing optical and electrical tasks. He came to M.I.T. in 1966 following undergraduate work at the University of Wisconsin and joined the faculty in 1970. . . . Since 1975 director of the Artificial Intelligence Laboratory, Professor Winston is known for research on computer learning and as the author of the leading undergraduate textbook in the field; he joined the department faculty upon completing graduate study in 1970.

Arvind came to the U.S. in 1970 following training in computer science at the Indian Institute of Technology, and after graduate study at the University of Minnesota taught at the University of California in Irvine before coming to M.I.T. in 1978; he is considered a world leader in the special field of computer architecture known as dataflow. . . . Professor Humblet is a specialist in data networks; he came to M.I.T. in 1973 following undergraduate study at the University Catholique de Louvain. . . . An outstanding young leader in signal processing, especially for speech and images, Professor Lim earned three degrees from M.I.T. before joining the faculty in 1978.

Mason F. Miller, S.M.'41, writes, "Recently retired at Cincinnati (Evendale) as performance engineer for GE's Aircraft Engine Business Group with about 13 years service. Previously I worked for North American Rockwell (now Rockwell International), Allison Division of General Motors, Air Research Manufacturing Co. of Arizona, NACA (now NASA) Cleveland and Langley Research Centers, U.S. Bureau of Ships (Bath, Me.), and AT&T Long Lines. I came to M.I.T. with a B.S. degree (1940) from the University of Nebraska."

Gerald G. Probst, S.M.'56, president of the Sperry Corp., has been elected chief executive officer and chairman of the board. . . . **Leonard Kleinrock,** Ph.D.'59, of the UCLA Computer Science Department has been named co-winner of the prestigious L.M. Ericsson Prize for "notable contributions to telecommunications research and development, particularly in laying the theoretical groundwork for the so-called 'packet switching technology'." The presentation was made by King Carl Gustav of Sweden in Stockholm on May 5.

Cary Judson King, Jr., '49, colonel (retired) in the U.S. Army, passed away on February 3, 1982. He was a graduate of the U.S. Military Academy (1924); received an S.M. degree from Sheffield Scientific School, Yale University; and was an instructor of chemistry and electricity (1935-40) at the U.S. Military Academy. During World War II he was signal officer with the 11th Air Force in Alaska, deputy chief air signal officer in the European theater, and chief of the Fixed Facilities Section of the Army Air Force. During his army career he was the recipient of the Legion of Merit, the Bronze Star, and the French Medaille de l'Aeronautique. Retired from the army in 1954, he joined RCA Laboratories, Princeton, N.J., for a 20-year period. With RCA he was the organizer and curator of the David Sarnoff Library. . . . **Arthur J. Dore,** '41, of Largo, Fla., passed away on February 22, 1982; no details are available.

VI-A Program

VI-A's 65th class will number 91 new students plus one transfer from Course III-B (Materials Science and Engineering Cooperative). The new class was selected from 178 applicants (making a 51.1 percent acceptance rate). Although down in total numbers from last year (195 applicants), this year's applicants represent a one percent increase in the fraction of Course VI applying.

Following last March's intensive two days of interviews, the VI-A companies came up with 102 openings—these in spite of current recessionary economic trends. Meanwhile, the Electrical Engineering and Computer Science Department is continuing to keep its lid on the new class size at 85-90 for the second of three years in order to bring the VI-A Program down to a manageable total of about 250 students.

This summer Analog Devices, Inc., will have its first students at its Semiconductor Division, Wilmington, Mass. Professor L. Rafael Reif has been selected to serve as their VI-A faculty advisor.

We congratulate **Lawrence G. Roberts,** '59, who is a co-recipient of the IEEE's 1982 L.M. Ericcson Prize for "significant contributions within telecommunications research and engineering—for important work on new techniques for data transmission."

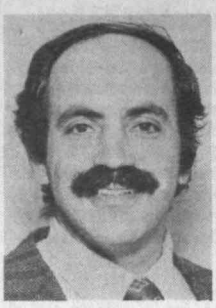
At the spring conference of the Employment Management Association held this year in Boston, **Raymond S. Stata,** '57, chaired a top management panel on the Human Resource Function. Analog Devices, Inc., of which Ray is founder and chairman of the board, is the second company founded by a VI-A alumnus to join VI-A—the first was Texas Instruments, Inc., founded by **Cecil H. Green,** '23.

On campus in March doing recruiting for Data Architects, Inc., Waltham, Mass., was **Lawrence Kernan,** '75. He and an associate enjoyed a pleasant luncheon with Mr. Tucker.

Robert D. Hempstead, '65, who has been with IBM Corp., has left to form a new company named Cybernex, Inc., San Jose, Calif. He's a senior vice-president. The firm is involved in thin film data

P.H. Winston

N.H.D. Hopkins



R.A. Weinberg

J.W. Belcher

storage recording heads.

On April 14, work finally began on the construction of the new five-story EG&G Educational Center which will be fitted in between Buildings 36 and 38 and will abut the north end of Building 24. The cement steps have been broken up and removed and foundation work has begun.

A reminder that the department celebrates its centennial this year with a special program and ceremonies on October 2 and 3, 1982. A special symposium will be held discussing the future cooperative role of industry and the university training of engineers. All are invited to attend. And we hope especially that many VI-A graduates will do so. There will be a mailing on this, but contact Department Headquarters (617-253-4601) if somehow you get missed.

Visitors to the VI-A office since the last issue included. **Richard J. Byrne,** '79, with ITT's LTC Advanced Technology Center, Shelton, Conn.; **Edward C. Giaimo,** '74, in corporate development at Data I/O, Seattle, Wash.; **Daniel G. Jablonski,** '76, just back from Cambridge University, England, where he obtained a doctorate, returning to duty at the Naval Surface Weapons Center's White Oak Laboratory, Silver Spring, Md.; and **Joshua L. Koslov,** '79, with RCA's Sarnoff Laboratories, Princeton, N.J.—John A. Tucker, Director, VI-A Program, Room 38-479, Cambridge, MA 02139.

VII

Biology

Professors **Richard O. Hynes,** Ph.D.'71, and **Sheldon Penman** are recipients of Guggenheim Fellowships for 1982-83. Professor Hynes will undertake an immunological analysis of the human nervous system, and Professor Penman will study the dynamics of skeletal structures in cells.

Two promotions to the rank of full professor will be effective July 1: **Nancy Haven Doe Hopkins** and **Robert A. Weinberg,** '64; and **Robert T. Sauer** will be promoted to associate professor. . . . At M.I.T. since 1973, Professor Hopkins is a virologist who has effectively used recombinant DNA technology and DNA sequencing to investigate genetic problems in leukemia; she studied at Radcliffe, Yale, and Harvard. . . . Until recently, Professor Weinberg has specialized in the field of animal virology and the mechanism for viruses to cause tumors in animals; he is now working in the field of the genetics of carcinogenesis, seeking to isolate cancer-causing genes by cloning techniques. . . . Professor Sauer is a leading protein chemist, bringing to that field the background of a molecular biologist/geneticist; he has been director of the department's Protein Chemistry Laboratory since joining the faculty in 1978.

Cecily C. Selby, Ph.D.'50, writes "I have been elected a member of the Corporation of Woods Hole Oceanographic Institution in June 1981 (past member M.I.T. Corporation) and am also chairing the Radcliffe Trustees' Committee on Educational Program Planning.

VIII

Physics

A proposal for studies in nuclear many-body theory has won a 1982-83 Guggenheim Fellowship for **John W. Negele,** professor of physics.

Four members of the department faculty will be promoted to full professor effective July 1: **John W. Belcher, Min Chen, June L. Matthews,** Ph.D.'67, and **Toyoichi Tanaka;** and five promotions to associate professor will be effective on the same date: **A. Nihat Berker,** '71, **Elizabeth S. Hafen, Shimon Levit, Robert P. Redwine,** and **J. Scott Whitaker.**

Professor Belcher is a space physicist who has concentrated on the properties of planetary and interplanetary space; his degrees in physics and mathematics are from Rice and Caltech. . . . At M.I.T. since 1972, Professor Chen has made notable discoveries in particle physics, including the first observation of the gluon. He came to the U.S. in 1964 to study at the University of California at Berkeley following undergraduate work at Tunghai University, Taiwan. . . . Professor Matthews' undergraduate degree is from Carleton College, and she is widely known for investigations of the electromagnetically-induced emissions of protons from nuclei. . . . A graduate of the University of Tokyo, Professor Tanaka is an experimental physicist who has specialized in the use of optical and light-scattering methods to study complex organic molecules, gels, and polymers.

Professor Berker's main interest is statistical mechanics and the theory of first- and second-order phase transitions; his advanced degrees are from the University of Illinois . . . A member of the faculty since 1978, Professor Hafen is an experimental particle physicist with a special interest in the strong interactions; she studied at Iowa State University. . . . Professor Levit is regarded as one of the country's most important young nuclear theorists; he studied at the Polytechnical Institute in Leningrad and the Weizmann Institute of Science, Israel, before joining the M.I.T. faculty in 1979. . . . An experimental nuclear physicist, Professor Redwine has focused on intermediate-energy nuclear interactions; his degrees are from Cornell and Northwestern, and he's been at M.I.T. since 1979. . . . Professor Whitaker studied at the University of California at Berkeley and came to M.I.T. in 1978; he has been involved in many of the recent important experiments in particle physics, including the discovery of the J/Psi particle.

Parr A. Tate, Ph.D.'52, writes, "On December 29, 1981, I retired from my job as director of the Protective Sciences Division of the Defense Research Establishment, Ottawa, Canada, a research agency of the Canadian Department of National Defense."

X

Chemical Engineering

Robert E. Cohen has been promoted to full pro-

No Incentives + No Integration = No Innovation in Construction

Arthur R. Anderson, Sc.D.'38, has been working in concrete for 50 years, ever since he first entered the University of Washington to study civil engineering in 1930. In that period there's been continuous technological change in concrete design and engineering, in much of which Dr. Anderson has been a leader. But there have been no quantum jumps in concrete technology such as have come to transportation (jet aircraft), electronics (solid-state circuits), and communications (radio and video).

The problem, speculates Dr. Anderson in concluding a series of autobiographical articles in the *Journal of the Prestressed Concrete Institute*: there are insufficient rewards for innovation in construction technology and inadequate financial commitment to research and development.

Two reasons, he thinks:

☐ The construction industry is fragmented, with responsibility diffused among clients, architects, engineers, contractors, and material suppliers. Partnerships between designers and builders are volatile, their terms and duration determined by the single project on which they chance to be temporary partners.

☐ Industry practice is governed by codes formulated by committees. Inevitably such codes advocate practices in which the committee members have confidence and experience. "Few incentives exist to encourage, recognize, or reward the engineer or builder who strives for the "upper bound'," writes Dr. Anderson.

It's different, for example, in the aircraft industry—where design, research and development, engineering, and manufacturing are performed by one integrated organization. An unprecedented format for the construction industry, admits Dr. Anderson, but perhaps it would help.

As the editor of the PCI *Journal* notes, Dr. Anderson has been known throughout his career for "innovative designs and daring technological advances"—mostly centering in new technologies and applications for prestressed concrete.

M. Chen

J.L. Matthews

T. Tanaka

C.C. Counselman III

fessor in the department, effective on July 1. He is an expert in polymer engineering and science, particularly in the structure and properties of polymers. A graduate of Cornell and Caltech, Professor Cohen joined the M.I.T. faculty in 1973 after a postdoctoral year at Oxford University, England.

Robert A. Brown, a specialist in the modelling of fluid mechanics and transport processes, has been promoted to associate professor as of July 1; at present the Joseph R. Mares Assistant Professor, Dr. Brown studied at the Universities of Texas and Minnesota.

Ulrich W. Suter, until last year a member of the Department of Industrial and Engineering Chemistry at the Eidgenossische Technioche Hochschule in Zurich, joined M.I.T. early in 1982 as the first Texaco-Mangelsdorf Career Development Professor in the Department of Chemical Engineering. Dr. Suter, a native of Switzerland, holds degrees from ETH-Zurich; his special interests include physical macromolecular chemistry, polymerization processes, and new polymeric materials. The professorship honors the late **Theodore A. Mangelsdorf,** '26, who was executive vice-president of Texaco, Inc., at the time of his retirement in 1966.

Jan W. Mares, S.M.'60, reports, "In August 1981 I resigned from Union Carbide Corp. and became the assistant secretary for fossil energy of the Department of Energy, Washington, D.C."

XI

Urban Studies and Planning

Lawrence Bacow, '72, assistant professor of law and environmental policy, will be promoted to the rank of associate professor effective July 1. At present actively involved in developing policies for siting hazardous waste facilities in Massachusetts, he is the author of *Bargaining for Job Safety and Health.* Professor Bacow holds advanced degrees in public policy from Harvard, and he also holds the J.D. degree from Harvard Law School.

Sarah Kuhn, a graduate student in the department, is the author of *Computer Manufacturing in New England* (Cambridge: Harvard-M.I.T. Joint Center for Urban Studies, 1982, $12). It's described as the first-ever overview of the New England computer industry—its "dramatic rise" and changing structure, and the effects of competition and maturation on its viability.

Joyce C.C. Wang, M.C.P.'61, was awarded a Ph.D. degree in urban and environmental studies from Rensselaer Polytechnic Institute, Troy, N.Y., in December 1981. She is working in the Office of Research and Economic Development of Oklahoma City.

XII

Earth and Planetary Sciences

Professors **Irwin I. Shapiro** and **Sean C. Solomon,** Ph.D.'71, have been awarded Guggenheim Fellowships for 1982-83—Professor Shapiro for new experiments in very-long-baseline radio interferometry, Professor Solomon to model mid-ocean ridge tectonics and planetary gravity anomalies.

Charles C. Counselman, III, '64, associate professor of planetary sciences, will be promoted to full professor effective July 1. Professor Counselman joined the faculty in 1969 upon completion of graduate studies at M.I.T. in electrical engineering and instrumentation, and he has since then worked in a number of fields in planetary science and astronomy—including, for example, serving as principal investigator for the Pioneer Venus experiment on atmospheric circulation.

Edward A. Boyle, Ph.D.'76, assistant professor of chemical oceanography, will be promoted to associate professor effective July 1. He is the author of what are generally considered the best values for trace metal concentrations in the ocean, and he is an expert in the use of geochemical indicators to study the dynamics and evolution of the seas. Dr. Boyle joined the faculty in 1977 after receiving his doctorate in the joint M.I.T./Woods Hole program.

Francisco Querol-Sune, S.M.'68, writes, "After a six-month leave working for a private company in Tehnacan (state of Puebla, Mexico), I have come back to the National University of Mexico as chairman of the Department of Geology and Geotechnics."

XIII

Ocean Engineering

Joao Maneul Gomes de Oliveira, Ph.D.'78, Edgerton Assistant Professor of Ocean Engineering, will be promoted to associate professor effective July 1. A native of Portugal, Professor de Oliveira came to M.I.T. in 1970 and has been a member of the faculty since completing his Ph.D.; his special field is structural mechanics, including especially the static and dynamic behavior of ships and offshore platforms.

Michael S. Triantafyllou, Sc.D.'79, is now the Henry L. Doherty Assistant Professor in Ocean Utilization. Under this assignment, he'll continue design of an unmanned, tethered, underwater vehicle for carrying heavy maintenance and repair equipment to depths of 5,000 to 13,000 feet—a crucial need of the offshore industry for future exploration efforts. A native of Greece, Professor Triantafyllou studied at the National Technical University of Athens before coming to M.I.T. in 1975.

Robert J. Anderson, '56, is currently general manager, ship repair facility of HBH Co., Jeddah, Saudi Arabia. . . . **David B. Flanagan,** S.M.'62, reports, "Being transferred from Boston (where I am commander, Coast Guard Group) to Panama, to take on a development job as marine safety advisor to the Marine Bureau for the government of Panama and assistant chief of the Navigation Division of the Canal Commission." . . . **David J. Ben Daniel,** Ph.D.'60, has been named senior vice-president of the American Research and Development Division of Textron, Inc., Boston, Mass.

Edward S. Carmick, S.M.'60, writes, "I am fully retired and in rather bad health. I keep up my large vegetable and flower garden and attended my 50th reunion at the United States Naval Academy in 1980. I keep in touch with many old navy hands." . . . **John E. Halkyard,** Sc.D.'71, reports, "I recently started John E. Halkyard & Co., a consulting engineering firm in ocean engineering and mechanical systems development . . . Daughter Tanya born on March 29, 1981." . . . **Gabrielle Donnay,** Ph.D.'68, currently a professor at McGill University, spent the first semester of 1981-82 in New Zealand, lecturing at various universities. . . . **F.A. Packer, Jr.,** '51, writes, "Still working on Exxon's four tankers being built in Taiwan. They all should be delivered this year. Then I hope the commuting back and forth will no longer be necessary."

XIV

Economics

Lawrence H. Summers, '75, who will be promoted to the rank of associate professor effective July 1, will become the new Class of 1922 Career Development Professor. Dr. Summers, who received his Ph.D. at Harvard earlier this year, is a specialist in macroeconomics and public finance—especially the determinants of saving and investment decisions. His earlier work on the structure and cyclical behavior of unemployment is a "major contribution," says Professor E. Cary Brown, head of the department.

Professor **Peter A. Diamond,** Ph.D.'63, will be on leave from the department next year to work on his Guggenheim Fellowship project: an approach to macroeconomic policy through search equilibrium.

Representative **Les Aspin,** Ph.D.'65, is campaigning for his seventh term in the U.S. House of Representatives from the First District (Kenosha and Racine) of Wisconsin.

XV

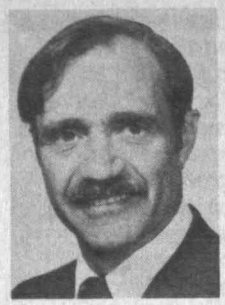
Management

Dr. **Stan Neil Finkelstein,** '71, assistant professor of health management, will be promoted to the rank of associate professor, effective July 1. Dr. Finkelstein's research has been on policy issues concerning the use, impact, and cost of new health care technologies and on biomedical innovation, and he has also served as research associate and lecturer in political science at M.I.T. Dr. Finkelstein holds M.I.T. degrees in chemical engineering and the M.D. from Harvard Medical School.

Professor Phyllis Wallace spent the spring term as distinguished scholar in residence at Radcliffe College, continuing her study of the upward mobility of women in management who earned master's degrees in that field between 1975 and 1979 and consulting with Radcliffe students in the Henry A. Murray Research Center, a national repository for social science data on the changing life experiences of American women.

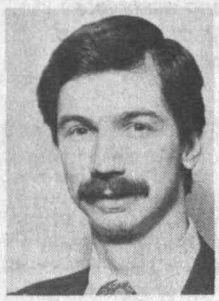
The 1982-83 class of Sloan Fellows which entered M.I.T. this June includes 57 mid-career executives—49 men and 8 women from the U.S. and 11 foreign countries. Fifteen percent of the U.S. participants are blacks—"the largest number of minority candidates in the history of the program," according to Alan F. White, director.

Clinton Makepeace Jones, S.M.'58, writes, "I opened my own professional practice as a management consultant in 1981 to provide consulting services in the areas of physical distribution, manufacturing, and materials management. Our family continues to grow—we now have three grandchildren." . . . **H.R. Johnston,** S.M.'67, is currently managing director (for Venezuela) for the Management Analysis Center, a Cambridge management consulting firm, living in Caracas with wife Florence and son, Josh. . . . **Michael A. de Marco,** S.M.'68, writes, "Michael and Barbara are ad-



W.M. Hollister

R.G. Prinn



C.L. Cooney

I. Tayler

justing to their new suburban life-style after returning to the states last year. With a big house and four children under age six, they're caught up in domesticity! Michael, a vice-president at Citicorp, is working on developing new corporate finance services."

David Tso, S.M.'74, reports his promotion last year from director of crude oil trading to manager, system supply, international refined products in the Gulf Oil Trading Co. . . . **Robert T. Blakely,** Ph.D.'70, writes, "I have recently left Morgan Stanley to become senior vice-president and chief financial officer of Tenneco, Inc. Houston is booming and the business community remains extremely enthusiastic." . . . **David L. Bodde,** S.M.'73, is currently assistant director of the Congressional Budget Office and reports that he has four children, the last one a girl born on June 1, 1981—"*really* the last one," he says. . . . **Frank H. Mason III,** S.M.'65, has been named controller for the Ford Motor Credit Co. . . . **Giyora Doeh,** S.M.'58, reports, "Have recently gotten involved in a shared housing project. With one other person (so far) bought and moved into a large four-bedroom home in the Mar Vista Hill section (Los Angeles) and am now interested in having others join us. Last spring I visited London to attend my brother's wedding and was able to spend a truly delightful evening with **Bob Doyle,** S.M.'58, and family."

Sloan Fellows

Charles R. Grader, S.M.'74, writes, "I have finally left the government and am trying my hand in the private sector—as all good Sloan Fellows are conditioned to do. As president of a mixed mining company owned by six multinationals, the government of Guinea, and the Cie de Bauxites de Guinea, I am learning a lot and having fun." . . . **Richard Brackeen,** S.M.'75, writes, "In November 1981 I was promoted to vice-president of strategic planning and business development, Aerospace Headquarters of the Martin Marietta Corp." . . . **Charles W. Campbell,** S.M.'63, reports, "I have taken my retirement from my last position with Asamco, Inc., as general manager of the Western Mining Department. I am now operating as an independent mineral consultant, specializing in mineral production, management, and evaluation in Tucson, Ariz." . . . **LeRoy E. Day,** S.M.'60, director of STS systems engineering and integration (Office of Space Transportation Systems) at NASA Headquarters, Washington, D.C., has received NASA's highest award—the Distinguished Service Medal—for his work in the space shuttle program.

XVI

Aeronautics and Astronautics

Walter M. Hollister, '53, an expert in the fields of guidance and control, will be promoted to the rank of full professor effective July 1. Professor Hollister has been a member of the faculty since 1963, and in this period he has initiated a number of undergraduate courses in flight measurements and interplanetary flight, using his experience as a pilot to enhance both his research and teaching.

XVIII

Mathematics

Professor **Michael Arbid,** Ph.D.'63, who's a member of the University of Massachusetts (Amherst) faculty in linguistics, cognitive philosophy, and psychology the field of cognitive science, is completing a year as U. Mass. faculty fellow by preparing for the prestigious Gifford Lectures on Natural Theology to be delivered next fall at the University of Edinburgh. His subject, he told Alice Dembner of the *Hampshire Gazette*: " 'the construction of reality'—how we perceive the world around us and why some perceive God and others do not." Earlier, with the reprieve from teaching duties provided by the fellowship, Professor Arbid completed two textbooks on the theory of computation.

George Lusztig, professor of mathematics at M.I.T., will be on leave in 1982-83 with a Guggenheim Fellowship for studies in representations of finite groups.

XIX

Meteorology and Physical Oceanography

Ronald G. Prinn, Sc.D.'71, associate professor of meteorology, will be promoted to the rank of full professor on July 1. Professor Prinn's specialty is atmospheric chemistry of the earth and other planets, and he had made important measurements of the earth's ozone layer as well as of the atmospheric compositions of many planets. A native of New Zealand, Professor Prinn came to the U.S. for graduate study at M.I.T., and he remained to join the faculty in 1971.

XX

Nutrition and Food Science

Charles L. Cooney, Ph.D.'70, associate professor of biochemical engineering, will be promoted to full professor effective July 1. Combining professional work in chemical engineering, biochemistry, and microbiology, Professor Cooney has studied a number of problems in the control of microbial processes and biological processing for pharmaceuticals, fuel, and chemicals production. Professor Cooney came to M.I.T. after completing undergraduate work in chemical engineering at the University of Pennsylvania, and he joined the faculty in 1970.

A long-range project to upgrade the Wright Brothers Wind Tunnel has gained a $50,000 contribution from Fairchild Republic Co. The photograph shows Professor James W. Mar, '41 (left), head of the Department of Aeronautics and Astronautics, receiving the company's check from Robert A. Arrighi, manager of administration technology and business development at Fairchild Republic. At the right are Professor Judson R. Baron, Sc.D.'56, and Frank H. Durgin, director and associate director, respectively, of the tunnel. (Photo: Calvin Campbell)

XXI

Humanities and Social Science

Professor **Albert R. Gurney, Jr.,** has added another to his series of theatrical successes—*The Dining Room,* which opened off-Broadway this spring. "Clear-eyed, touching, and buoyantly funny," wrote T.E. Kalem in *Time,* and Frank Rich, drama critic for the *New York Times,* described the production as "often funny and rueful and, by the end, very moving." Professor Gurney explains the play as focussing on the folkways of an endangered species of America, the Northeastern WASP. Its characters, said Mr. Rich, are "exemplars of an insular upper-middle-class way of life that social history has outrun." Professor Gurney was on leave in 1981-82, working in New York under a playwriting grant from the National Endowment for the Arts.

Merritt R. Smith, Professor of the history of technology in the Program on Science, Technology, and Society, and **Barry L. Vercoe,** associate professor of music and technology, have been awarded Guggenheim Fellowships for 1982-83. They'll be on leave to pursue studies in technology and culture in 19th-century America (Professor Smith) and computer-assisted music composition (Professor Vercoe).

Irene Tayler, scholar in the field of English romantic poetry and art who is the first occupant of the Thomas Meloy Chair of Rhetoric at M.I.T., has been promoted to full professor, effective July 1. Professor Tayler holds degrees from Stanford in philosophy, American literature, and English literature.

Three members of the department will be promoted on July 1 to the rank of associate professor: **Elizabeth J. Garrels,** assistant professor of Spanish; **Thomas E. Postelwait,** assistant professor of writing; and **Jay J. Rosellini,** assistant professor of German. Professor Garrels' interests are in Latin American literature—especially its political and social aspects; Professor Postelwait is a student of the relationship between science and culture in the 19th century; and Professor Rosellini's specialty is East German literature.

Promotions to associate professor will also be effective on July 1 for two members of the Program in Science, Technology, and Society: **David F. Nobel,** assistant professor of the history of technology, and **Charles F. Sabel,** Ford International Assistant Professor of Social Science. Professors Nobel's special interest is the action of social forces in determining the development of new technologies; a member of the faculty since 1978, he holds degrees from the Universities of Florida and Rochester. A political sociologist, Professor Sabel's subject is the relation between the division of labor and the organization of society; his degrees are from Harvard.

XXII

Nuclear Engineering

Richard K. Lester, Ph.D.'79, Edgerton Assistant Professor of Nuclear Engineering, will be promoted to associate professor, effective July 1. A prolific writer on nuclear policy issues, Professor Lester has specialized on nuclear waste management and weapons proliferation; he came to M.I.T. in 1975 with a degree in chemical engineering from Imperial College, London, and joined the faculty in 1979.

Robert H. Wilcox, S.M.'58, reports that he was recently elected a vice-president of Stone and Webster International Corp. He joined Stone and Webster upon retirement from the U.S. foreign service in July 1981 (last post—counselor for scientific and technological affairs, U.S. Embassy, Mexico City), and since January 1 he has been serving as senior regional manager of international marketing, with primary responsibility for Latin America and the Caribbean. . . . **John A. McClary,** S.M.'57, has been promoted to technical specialist in the Nuclear Safeguards and Licensing Division at Sargent and Lundy, Chicago, Ill., an engineering firm.

Technology and Policy Program

Jonathan Weiss, '78, is working for the Montgomery County Council in the Office of Legislative Oversight, Rockville, Md. The office does investigations and evaluations of county-funded programs. . . . **David Kagan,** '80, is in the Management of Engineering Program in the Sloan School of Management. Since graduation from M.I.T., he has been working for MITRE, Bedford, Mass. . . . **Gail Lee,** '81, is an environmental engineer for the Potomac Electric Power Co. (PEPCO), Washington, D.C. . . . **Bob Chen,** '82, and his wife, Meredith Golden, will start their doctoral programs in geography in September at the University of North Carolina, where Bob has a Morehead Foundation Graduate Fellowship. They both have been working for the International Institute for Applied Systems Analysis (IIASA) in Austria since January 1982.—Professor Richard de Neufville, Chairman, Room 1-138, M.I.T., Cambridge MA 02139.

Rehearsing for a spring festival performance, Craig Russell, '83, leads the M.I.T. Concert Band—of which he is president—in his own Symphony for Band. It's Mr. Russell's second band composition; his first—Fantasma—was written while he was in high school and played by the band during his freshman year at M.I.T.

Under the Domes

"Navigator for the Shakespeare Ensemble, friend of the undergraduates, and unabashed lover of M.I.T." is how William J. Hecht, '61, executive vice-president of the Alumni Association, describes Richard A. Knight, '47. The occasion for the comment—and for the picture above—was a reception in Mr. Knight's honor by the Alumni Council late in April; he will leave his post as secretary of the Alumni Association on July 1 to return to private business. In this picture, made during the Alumni Council dinner following the reception, are Angus N. MacDonald, '46 (left), president of the Alumni Association, Mr. Hecht, and Mr. Knight.

San Francisco or Philadelphia: Alumni Officers Must Choose

Alumni officers will have their choice of conferences in two locations next fall as they join colleagues to plan alumni activities for the 1982-83 year. The idea, of course, is to reach out to workers who have been unable to attend the traditional Cambridge Alumni Officers Conferences.

The schedules in San Francisco (September 24 and 25) and Philadelphia (October 8 and 9) are similar: workshops on alumni relations, the Alumni Fund, class activities, and the Educational Council during Friday afternoon and evening; general Alumni Association business meetings on Saturday morning; and special sessions on new technological developments at M.I.T. on Saturday afternoon. Both programs will conclude with Saturday receptions and dinners at which President Paul E. Gray, '54, will be principal speaker.

The location in San Francisco is the Hyatt on Union Square, where the Saturday afternoon program will be devoted to very-large-scale integrated circuits (VLSI) technology; speakers will include Professors Richard B. Adler, '43, Paul Penfield, Jr., Sc.D.'60, Dimitri Antoniadis, and Gerald J. Sussman, '68. At the Bellevue Stratford in Philadelphia, Professors Henry Jacoby, David C. White, and William G. Thilly, '67, will describe economic and environmental issues in relation to U.S. energy needs. For further information: Joseph J. Martori, associate secretary of the Alumni Association, Room 10-110, M.I.T.

How the UAP Adds It Up

"We really didn't want to change students' lives," say John DeRubeis, '83, and Kenneth Dumas, '83, of their administration as president and vice-president of the Undergraduate Association in 1981-82. So they're not worried by the fact that they can't claim a "major impact" on the life of the typical M.I.T. undergraduate.

But their low-key effort, they told Andrew Robbins, '83, of *The Tech*, should be credited with two significant changes:

☐ Increased funding from M.I.T. for the Undergraduate Association's Finance Board, to be used for various student activities.

☐ An invitation to the Undergraduate Association president to attend many meetings of the high-level Academic Council. Next year, Mr. Dumas told Mr. Robbins, "we hope that he has voting power there."

Chryssostomidis for Sea Grant

Chryssostomos Chryssostomidis, Ph.D.'70, associate professor of naval architecture, is the new director of the M.I.T. Sea Grant Program, effective July 1. He succeeds Dean A. Horn, N.E.'49, who joined the program as executive officer in 1970.

Professor Chryssostomidis has what Professor Kenneth A. Smith, '58, vice-president for research, calls "an impressive record of teaching and research" in ship design and offshore marine operations. His current Sea Grant work is the design of a ship for carrying nuclear wastes to a deep-ocean disposal site, and he's now preparing a study of ocean-going ships with "unconventional sections" to minimize wave-induced motion.

Sponsored Research: $193 Million But Slowing Growth

Sponsored research on the campus will be about $192.7 million for 1981-82, up from $184 million in 1980-81. But the growth rate will slow—from nearly 10 percent a year during the late 1970s to only 4.8 percent between last year and this, according to projections of Robert M. Dankese, associate budget director.

The decline will result chiefly from cuts in government-sponsored energy research—about $4.7 million in the Bitter National Laboratory, where the $4 million MHD research program has terminated, and $2.6 million in Energy Department funding for the M.I.T. Energy Laboratory.

Without these two decreases, said Mr. Dankese in a report to the Academic Council during the spring, campus research would have increased 9.3 percent between 1980-81 and 1981-82. Research volume at Lincoln Laboratory for 1981-82 will be just over $155 million, up 5.4 percent from the previous year.

Major recipients of sponsored research funds during the current year will be the Plasma Fusion Center ($16.1 million), Laboratory for Nuclear Science ($15.2 million), Energy Laboratory ($11 million), Department of Nutrition and Food Science ($10.5 million), National Magnet Laboratory ($10 million), Research Laboratory for Electronics ($9.7 million), Chemistry Department ($9.5 million), Department of Earth and Planetary Science ($8.8 million), Biology Department ($7.9 million), Department of Materials Science and Engineering ($6.6 million), and Laboratory for Computer Science ($6.5 million).

Major funding sources will include the Department of Energy ($43.7 million), Department of Health and Human Services ($32.5 million), National Science Foundation ($30.5 million), and

Department of Defense ($28 million). Research sponsored by industry in 1981-82 will total some $20 milion, according to Mr. Dankese's estimates—up from $17 million in 1980-81 and $13 million in 1979-80.

Cambridge, Here We Come!

Eighty-nine of the 500 outstanding college students awarded three-year National Science. Foundation fellowships for graduate study in science and engineering have selected M.I.T. as the place they want to attend. That's an unprecedented 18 percent.

The Institute has been first before, but never by such "an overwhelming margin," says Leslie A. McIntyre, assistant to the dean of the Graduate School.

In addition, seven of 55 minority students awarded three-year NSF minority graduate fellowships selected M.I.T. as their first choice.

Women's Place in a Man's Land

The sciences are not the male fortress they used to be.

The 160 women who attended the conference for women in engineering, held at M.I.T. on April 3, are proof of that. They have chipped away at that fortress but they still face a formidable male stronghold in engineering.

"These are women used to being in a minority," says Margaret Coleman, '50, president of the Association of M.I.T. Alumnae (AMITA). "But they still need psychological support."

Women engineers attend schools where they encounter only a handful of female classmates and go on to jobs where they may be the only woman in the lab or office.

Given the aura of "objectivity" that stamps the field, women engineers should be able to compete with their male counterparts on a reasonably straightforward basis. Not so, says Ms. Coleman. The discrimination may be less blatant but it is there—a powerful block to women pursuing a career in engineering.

To provide some support for each other, AMITA and the Society of Women Engineers sponsored the April conference. Most of the women who attended were from the Boston area and they focused on exploring career options and strategies for successfully pursing those options.

The theme of this year's meeting was "Navigating Change," building on last year's topic, "Getting On Once You've Gotten In." Affirmative action can help get a woman engineer in the door, a woman engineer said, but beyond that she's on her own.

Navigating change is not getting any easier. The poor economy has put the squeeze on women engineers, Ms. Coleman says. As the newest and lowest on the totem pole, they are the first to be let go when the cutbacks come—a pattern that women and minorities are experiencing in many areas. Seniority has become the excuse for undoing the gains made by affirmative action programs.—*Judy Cooper*

(Reprinted by permission from Equal Times. *© 1982 Equal Times, Inc.)*

Big Screw to Brister

Frances E. Brister, administrative assistant in the Chemistry Department, is notorious above all others this year for running a tight ship—perhaps too tight? She emerged the victor in the Big Screw Contest early this spring, followed closely by Degmar R. Ponzi, lecturer in chemistry.

Nobody else was even close.

Scientific Communication and National Security

Three members of the M.I.T. community are principals in a new National Academy of Sciences study of the relations between university research and national security—John M. Deutch, '61, dean of the School of Science; James R. Killian, Jr., '26, president emeritus; and Dr. Alexander Rich, Sedgwick Professor of Biology. The study, headed by Dale R. Corson, president emeritus of Cornell University, will tackle the controversial issue of how government should—and should not—control the international transfer of knowledge and information with potential military applications.

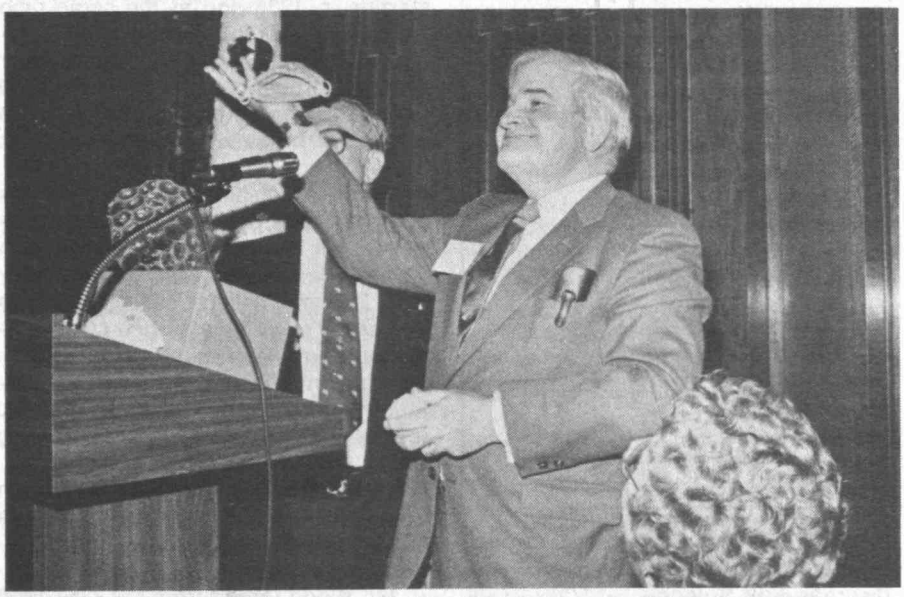
New Head for Chemistry

Professor Christopher T. Walsh, who holds appointments in both biology and chemistry departments, becomes head of the Department of Chemistry this summer. His research and teaching center in enzyme chemistry and molecular toxicology, and both have figured in his work as associate director of the Whitaker College of Health Sciences, Technology and Management—a post which he now relinquishes.

Professor Walsh succeeds James L. Kinsey, professor of chemistry who has been head of the department since 1977; Dr. Kinsey will return to teaching and research in the field of molecular beams and atomic and molecular collisions.

Professor Walsh studied at Harvard and Rockefeller University (Ph.D. 1970); he came to M.I.T. in 1972.

David S. Greenlaw, S.M.'47, vice-president of Eastman Kodak Co., as opening speaker for a "Technology/ Rochester" symposium of the M.I.T. Club of Rochester on March 13, assigned to technology the chief responsibility for Rochester's "exceptional quality of life. . . . Technology is the way man adds richness and vibrancy to living," he said. Other speakers added details to the theme, drawing on activities of such Rochester companies as Eastman Kodak, Bausch and Lomb, the Gleason Works, Hansford Manufacturing Co., and Xerox Corp. Finally President Paul E. Gray, '54, of M.I.T. concluded the meeting by noting a dilemma for all those who seek to move technology toward new usefulness: "We are engaged in understanding the future and preparing young people for future leadership," Dr. Gray told business leaders in Rochester, "while we are simultaneously shaping that future through scientific and technological changes whose outcomes are notoriously difficult to predict." Among those present at the conference, in the photo above: front row: Shirley M. Picardi, S.M.'72, secretary of the M.I.T. Alumni Association; President Gray; James K. Littwitz, '42, conference moderator; and Charles C. Park, '50, president of the M.I.T. Club of Rochester. Behind: William N. Hosely, '48, symposium chairman; William J. Hecht, '61, executive vice-president of the Alumni Association; Angus N. MacDonald, '46, president of the Alumni Association; and Gerald L. Wilson, '61, dean of engineering at M.I.T. (Photo: Howard Chou, '76)



Welcome to "the big apple." More than 550 alumni and friends came to the New York Public Library Rotunda on March 18 to greet President Paul E. Gray, '54, and Priscilla Gray at the first official reception by the alumni in the Greater New York area since Dr. Gray became president. Their gift to the Grays: a Steuben glass apple, presented by Kenneth S. Brock, '48, deputy chairman for the event, who is largely obscured in the photograph by Dr. Gray's enthusiastic expression of thanks. (Photo: Calvin Campbell)

Meetings and Conferences

The following are among major meetings now scheduled at M.I.T. and by M.I.T. related groups during the balance of this year (for information: Joseph J. Martori, associate secretary of the Alumni Association, Room 10-115M). In addition, a group of 50 short courses on timely topics in technology will be offered at the Institute during the 1982 Summer Session, and five programs in transportation technology and planning will be offered in July and August by the M.I.T. Center for Transportation Studies (for information: Office of the Summer Session, Room E19-356; and Center for Transportation Studies, Room 1-123).

August 2-5, 1982
Third International Conference on the Behavior of Onshore Structures

August 9-27, 1982
"Forecasting Transportation Demand"

August 16-20, 1982
"Microcomputers in Transportation"

August 16-20, 1982
"Railroad Operations, Planning and Management"

August 18-22, 1982
Research Conference of the International Federation of Organic Agriculture Movements

September 24-25, 1982 (San Francisco)
M.I.T. Alumni Officers Conference (West)

October, 1982
"Rebuilding America: Meeting the Challenge of Reconstruction"

October 2-3, 1982
Centennial Celebration of the Department of Electrical Engineering and Computer Science

October 5-7 (Amman, Jordan)
Conference on Regionalism and International Air Transportation

October 8-9, 1982 (Philadelphia)
M.I.T. Alumni Officers Conference (East)

October 10-12, 1982
Collection Management and Development Institute Conference

October 14-15, 1982
Second National Remanufacturing Conference

October 30, 1982
M.I.T. Enterprise Forum: Third Annual Conference on High Technology Small Business

December 13-14, 1982
"Remanufacturing in the 1980's II"

January 26-27, February 2-3, February 16-17, February 23-24, 1983
"Managing Productivity: Analysis Techniques for Improved Organizational Performance"

Spring, 1983
"Methods for Improving Productivity and Quality in America"

March 28-30, 1983
Noise Control Engineering Conference (NOISECON)

April 6-8, 1983
Optical Computing Conference

June 13-16, 1983
Science and Technology of MgO and Its Ceramic Applications

June 20-24, 1983
Third International Conference on the Biology of Vascular Endothelial Cells

June 27-29, 1983
Meeting of the Society for Industrial and Applied Mathematics

August 12-16, 1985
Cryogenics Engineering Conference

Humanities Adds Cognitive Science, Women's Studies, and Double Degrees with Science

Three new undergraduate academic programs will be offered in the School of Humanities and Social Science next fall:

☐ A new undergraduate major, leading to the S.B. degree, will be given by the Department of Psychology in cognitive science.

☐ The Department of Humanities will join the Program in Science, Technology, and Society to offer an experimental double-degree program in cooperation with several departments in the Schools of Engineering and Science.

☐ Two new interdisciplinary fields are being formed within the Department of Humanities, with a result that women's studies and Latin American studies will be added beginning in the fall as fields of concentration within Course XXI.

The new cognitive science program results from a planning grant of $225,000 from the National Endowment for the Humanities; "rich resources" already are available in the field at M.I.T., and an undergraduate program to capitalize on them will add little if any expense, according to the Psychology Department's proposal to the faculty. Man-machine interaction, artificial intelligence, and cognitive science will be among the areas for which students will be prepared.

The STS/Engineering double-degree program is precisely that, warns Professor Carl Kaysen, director of STS. Students in the program will be required to complete all requirements for two degrees, one in STS and one in a technical field—"obviously a demanding program," says Professor Kaysen.

Walter C. Wood, 1895-1982: Pioneer of Intercollegiate Sailing

Walter C. (Jack) Wood, who was sailing master at M.I.T. for nearly 30 years starting in 1936 and at the same time stimulated intercollegiate and community sailing programs at many other schools throughout the country, died following a heart attack at his San Diego retirement home on April 16; he was 87.

The M.I.T. sailing program which President Karl Compton, Professor Erwin Schell, and Mr. Wood founded in Cambridge spawned and hosted other New England college sailing activities and at the same time carried M.I.T. students to prominence in North American sailing competition, including representation on a number of U.S. Olympic teams. The Intercollegiate Yacht Racing Union was formed in 1938 under Mr. Wood's leadership, following Boston Dinghy Club races in which M.I.T. was host to some 27 colleges and universities.

Mr. Wood retired from M.I.T. in 1965 but nine years later returned for the dedication of an expanded sailing pavilion which is named in his honor. He was among the first to be inducted into the Intercollegiate Yacht Racing Union's Hall of Fame at the U.S. Naval Academy, where he also introduced and coached sailing.

Barbara L. McCarthy, 1925-1982

Barbara L. McCarthy, administrative officer of the Research Laboratory for Electronics since 1971, died on April 21 following a brief illness; she was 57.

A native of Boston, Ms. McCarthy came to M.I.T. as a secretary in 1963 and became administrative assistant in the Department of Electrical Engineering and Computer Science in 1969. She obtained secretarial training at Boston University and later studied accounting and business at the B.U. College of Business Administration.

Charles A. Thomas, 1900-1982

Charles A. Thomas, S.M.'24, retired chairman and president of Monsanto Co. who was a life member emeritus of the M.I.T. Corporation, died on March 29 at his winter home, Magnolia Plantation, Georgia. He was 82.

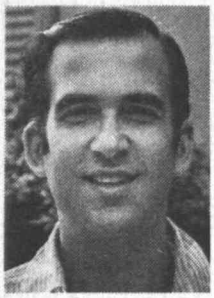
Howard W. Johnson, chairman of the Corporation, described Dr. Thomas as "a distinguished scientist and leader of the chemical industry, . . . a towering alumnus of M.I.T. and a staunch friend." Dr. Thomas joined the M.I.T. Corporation in 1950 and five years later was elected to life membership. Since then he had been active on a number of visiting committees and in many fund-raising efforts in behalf of M.I.T.

Deceased

Leon H. Smith, '04; October 26, 1981; 454 Route 32 North, New Paltz, N.Y.
Roger P. Ingalls, '05; March 14, 1982; 724 Brookside Dr., Birmingham, Mich.
Cedric Burgher, '13; March 16, 1982; 8915 Douglas St., Dallas, Tex.
Herbert B. Wood, '13; January 8, 1981; 5219 N 24th St. #101, Phoenix, Ariz.
Frederick B. Barns, '14; November 23, 1979; PO Box Drawer D, c/o Wells Fargo, San Mateo, Calif.
James W. Easter, '14; October 12, 1981; PO Box 367, Owings Mills, Md.
Harold A. Mayer, '14; February 3, 1982; 13920 SE Fairoaks Ave., Portland, Ore.
David M. Jones, '17; February 14, 1973; Hedgewood Ln., Schenectady, N.Y.
Benjamin Levey, '17; February 10, 1982; 260 West End Ave., New York, N.Y.
Lawrence P. Marshall, '18; February 11, 1982; 116 Whitman Rd., Longmeadow, Mass.
Paul W. Blye, '19; Feburary 6, 1982; 53 Dale Dr., Chatham, N.J.
Robert S. Bolan, '19; March 1982; 2030 E Leewyn Dr., Sarasota, Fla.
John A. Scarlett, '21; October 1977; 231 Semple St., Modesto, Calif.
Elroy S.J. Irvine, '22; April 29, 1980; 4000 Cathedral Ave. NW, c/o Westchest, Washington, D.C.
Allen S. King, '22; February 21, 1979; 3540 James Ave., Minneapolis, Minn.
Francis M. Mason, Jr., '22; March 14, 1976; 3515 Hillside Rd., Evanston, Ill.
William G. Rapp, '22; January 10, 1982; 16 N Chatsworth Ave., Larchmont, N.Y.
Alfred Wolf, '22; September 1, 1981; 424 Vassar Ave., c/o Mike Cole, Berkeley, Calif.
Wesley M. Hague, '23; February 10, 1982; 802 N Broad St., Apt. 2C, Selingsgrove, Penn.
Robert N. Wood, '23; March 1, 1982; 188 Medford Leas, Medford, N.J.
Edward J. Hanley, '24; March 13, 1982; 2685 Sunset Ln., Oak Hill Farms, Allison Park, Penn.
Francis J. Horgan, '24; 1975; c/o Patrick H. Horgan II, Opera House, Newport, R.I.
Charles A. Thomas, '24; March 29, 1982; 609 S Warson Rd., St. Louis, Mo.
Max Glickman, '25; 1974; c/o Atty. A.W. Pierce, 73 State St., Springfield, Mass.
James M. Lynch, '25; February 20, 1982; 810 Omar Dr., Escondido, Calif.
Carroll A. Oliver, '25; April 19, 1978; 1800 Saint Lucie Blvd., Stuart, Fla.
Frederick C. Balfe, Jr., '26; March 12, 1982; 827A Heritage Village, Southbury, Conn.
Neil B. MacLaren, '26; November 1981; c/o W. Wolfe, 9 Captain Pierce Rd., Scituate, Mass.
Charles Rich, '26; February 21, 1982; 25 Smith St., St. Albans, Vt.
Harry J. Moser, '27; January 20, 1982; Gracelyn Garden #7A, Asheville, N.C.
John F. Shaw, '28; February 1, 1982; 777 Saturn Dr., Apt. 403, Colorado Springs, Col.
Emmett E. Sprung, '28; November 10, 1981; 5623 Knollwood Rd., Washington, D.C.
Lucien H. Von Schilling, '28; December 28, 1981; 208 Bayview Dr., Yorktown, Va.
William T. Cathcart, '29; July 15, 1981; 2860 Claremont Dr., Tacoma, Wash.
Harry L. Beohner, '30; January 1, 1982; 40 Norvel Ln., Stamford, Conn.
Rael F. Morris, '30; August 28, 1981; 607 Willow, Coffeyville, Ks.
Freeman G. Corkum, '31; March 20, 1982; 2131 NW 42nd Ct., Lighthouse Point, Fla.
Louis C. Page, Jr., '31; November 27, 1981; 2507 Kenmore Courts, Austin, Tex.
Roger R. Trengove, '31; February 16, 1982; 26 Tanglewood Pk., Ponca City, Ok.
Henri B. Turner, '31; November 2, 1981; 20 Hadley St., Malden, Mass.
David F. Walters, '31; March 3, 1979; 314 Aqua Ct., Royal Oak, Mich.
Earle M. McKellar, '32; August 18, 1967; 10-2 Briarcilffe West, Myrtle Beach, S.C.
Frederic I. Miner, '32; January 12, 1981; c/o T.P. Turchetta, 551 McEntee Dr., Wadsworth, Ohio.
Gardiner A. Smith, '32; October 18, 1978; 143 E Lawrin Blvd., Terre Haute, Ind.
Charles C. Wyatt, '32; February 20, 1982; 1120 Eighth Ave., Seattle, Wash.
Serge J. Zaroodny, '34; August 1981; 2322 Sherwood Ln. RD #1, Havre De Grace Md.
Priscilla Maury, '35; February 12, 1982.
Charles D. Brown, '36; October 1981; PO Box 244B RD 2, Winchester, Va.
Abraham B. Levine, '38; September 4, 1981; 1441 Evergreen Ave., Plainfield, N.J.
Jacob Martin Rosse, '40; March 3, 1982; 105-D Semtary Dr., Mill Valley, Calif.
Alfred G. Ward, '40; April 3, 1982; 682 Hendler Rd., Severna Park, Md.
Robert C. Knauer, '42; November 20, 1980; 64 W Rayburn Rd., Millington, N.J.
John L. Senior, Jr., '42; March 14, 1982; PO Box 550, Southbury, Conn.
Franklin R. Farmer, '44; April 2, 1982; PO Box 38, Hampden, Maine.
Loy W.A. Renshaw, '46; February 11, 1982; 1119 SW 13th St., Boca Raton, Fla.
Don P. Aikin, '47; May 4, 1979; 6935 Lawnpark Dr., Brecksville, Ohio.
Rene S. Jullian, '47; April 11, 1982; 10906 NE Bill Point Ct., Bainbridge Island, Wash.
Irving E. Pengeroth, '57; January 28, 1982; 9 Lublin St., Arlington, Mass.
Henry J. Spalletta, '63; 1980; 1032 Pittiton Ave., Scranton, Penn.
Kenneth H. Kaiser, '64; June 5, 1981; 5959 S 12th St. #125, Tacoma, Wash.
Paul D. Birnbaum, '69; June 27, 1981; 65 Pinckney St., Boston, Mass.
James W. Hafner, '71; November 15, 1981; 2115 23rd St., San Francisco, Calif.
John G. Gaschnig, '72; March 4, 1982; 2348 Lida Dr., Mountain View, Calif.
Aubrey G. Davis, '74; August 2, 1981; 1417 Kingsbury Dr., Cincinnati, Ohio.
Alberto M. Rivas, '77; February 27, 1982; 5G Brandywine Rd., Amherst, Mass.
Rosemary J. Wojtowicz, '82; March 3, 1982; 16 Edgewood St., Three Rivers, Mass.

Puzzle Corner
Allan J. Gottlieb

Why Is It Always 8:18?



Allan J. Gottlieb, '67, is associate research professor of mathematical sciences at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St. New York, N.Y. 10012.

Winthrop Leeds, '39, a frequent contributor to Puzzle Corner, sent me a charming monograph of his work on Pythagorean triples. While I was intrigued by the appearance of several problems from Puzzle Corner, I was considerably more fascinated by a philosophical point made by Dr. Leeds. He recalled how, after he had made a long and painstaking classification of all triples

$A^2 + B^2 = C^2$ with $0 < A,B,C < 1000$

he received a letter from a friend, Dr. D. C. Lewis, giving a simple formula from which all these triples can be obtained easily. After some initial dismay, Dr. Leeds realized that it was searching for the triples that made finding them so rewarding. "Things handed to you . . . never seem so precious as the treasures earned by the sweat of the brow."

I am always amazed to find how far Puzzle Corner travels. The well-known Japanese puzzle creator Nob. Yoshigehara has sent me several of his mazes and other challenges, and some of these will appear in future issues.

Problems

JUL 1 We begin with an arithmetic progression of bridge problems from Douglas Van Patter:
You wish to maximize your chances in playing this nine-card suit:
Dummy: A K 10 x
Declarer: x x x x x
You play the A from the Dummy, and an honor falls on your right. It is well known in bridge circles that the odds are now nearly 2:1 in favor of finessing West for the other honor (Rule of Restricted Choice), provided that East is known to play either the Q or J at random from a doubleton Q-J holding. The problem is to consider what happens as the combined holding shrinks from nine cards to five while still maintaining the two honors (the limiting case is A K 10 in Dummy) and calculate the exact odds for the finesse in each case (nine cards, eight, etc.).

JUL 2 Roy Sinclair needs to land on the moon softly, so he writes:
A rocket containing 60 gallons of fuel approaches the moon (gravity is 5 ft./sec./sec.) tail-first with an initial velocity of 50 ft./sec. when at an altitude of 500 ft. Each second thereafter an integral number of gallons of fuel may be burnt, causing an upward acceleration of x ft./sec./sec., where $x = 2f - 5$. Find the sequence of one-second fuel burns that maximizes the maximum f while yielding a soft landing.

JUL 3 Winslow Hartford asks a "timely" problem:
Watchmakers all over the world display a symmetrical watch face in which the hands are set at 8:18. Although this was often believed to represent the hour of Lincoln's death, the custom actually is much older. Another idea is that the arrangement gives the jeweler a maximum amount of advertising space, but this doesn't hold water either. I would like to submit the idea that this watch-face division goes back to the "Golden Mean" of the ancient Greeks, in which the most esthetically pleasing division of space was believed to be that in which the larger part occupied $[(\sqrt{5}-1)/2]$, or approximately 72 percent of the total area. Test this idea. Is there an arrangement of the hands near 8:18 that is both symmetrical and in accord with the Golden Mean? If not, what is the time at the nearest symmetrical point and at the Golden Mean point?

JUL 4 Smith Turner wants you to find a rational number (other than 41/12) such that its square, when increased or decreased by 5, remains a square.

JUL 5 Our last regular problem first appeared in *Technology Review* in 1941 as part of an advertisement for Calibron Products:
Suppose that some new type of photographers' light bulbs undergoing a life-test for one week burned out as follows:
Sunday: ½ of the bulbs + ½ of a bulb,
Monday: ⅓ of the bulbs left + ⅓ of a bulb,
Tuesday: ¼ of the bulbs left + ¼ of a bulb, and so on progressively until
Saturday: ⅛ of the bulbs left + ⅛ of a bulb.
Assuming that there is only one filament in each bulb, what is the least number of bulbs that could have been left when the test ended? If the fractions had progressed in reverse order (starting with ⅛ of the bulbs + ⅛ of a bulb on Sunday), would the final result have been the same? Why?

Speed Department

JUL SD 1 My old classmate Chet Sandberg has the following "speed puzzle for college students":

```
  S E N D
  M O R E
---------
M O N E Y
```

What digits do the letters represent?

JUL SD 2 Irving Hopkins has a problem that's as speedy as your calculator: using radians, find approximate solutions to:
$u = \sin(v)$
$v = \cos(u)$.

Solutions

We begin with the solution to **JAN 3,** and an apology from the editors for the error which forced its omission from its proper place in the previous issue of *Technology Review.*

JAN 3 What is the minimal 3 x 3 magic square composed solely of prime numbers? (For this problem, 1 is considered prime and a minimal square is one whose (equal) row, column, and diagonal sums are minimal.)

Matthew Fountain used a new toy and an old book to help him solve this one; he writes:
I now have my own IBM personal computer, and the first program I ran on it was your JAN 3. It was a real learning experience. The instructions that come with the computer are fairly complete, but they are not organized so a rank beginner finds them easy to follow. However, the computer does a good job of pointing out errors.
The following magic square of primes is attributed to H. E. Dudeney by W. W. Ball in his book, *Mathematical Recreations and Essays:*

```
 7  73  31
61  37  13
43   1  67
```

It is the minimal magic square of primes when 1 is defined as a prime. The general form of magic squares of the third order is:

```
    A        3C - A - B      B
C - A + B      C         C + A - B
  2C - B     A + B - C     2C - A
```

To avoid squares that are rotations and reflections of others, one may impose the restriction $A<B<C$. Also $C<A+B$, to assure that $A + B - C$ is positive. If A, B, and C are restricted to primes less than 250, there are 27 independent magic squares of primes of order three. Dudeney's is the only one of these containing 1. The minimal magic square of primes where 1 is not a prime is:

```
17  113   47
89   59   29
71    5  101
```

Also solved by Charles Rivers, Edwin McMillan (who found a 1913 (!) reference), George Ropes, Avi Ornstein, Richard Hess, Emmet Duffy, Harry Zaremba, Winslow Hartford, John Woolston, William Katz, Lyndon Welch, and the proposer, Gertrude Fox.

Now we return to schedule with solutions to the problems published in the February/March issue:

FEB 1 On an island there are only two trees, A and B, and the remains of a gallows. According to an old map, treasure may be found by following these directions: start at the gallows, pace to A, turn 90° to the left, pace an equal distance, and drive a

stake. Return to the gallows, pace to B, turn 90° to the right, pace an equal distance, and drive another stake. Treasure is buried at a point half-way between the two stakes. A treasure hunter, coming to the island, found the two trees, but all vestiges of the gallows were gone. None the less, he found the treasure. How did he do it?

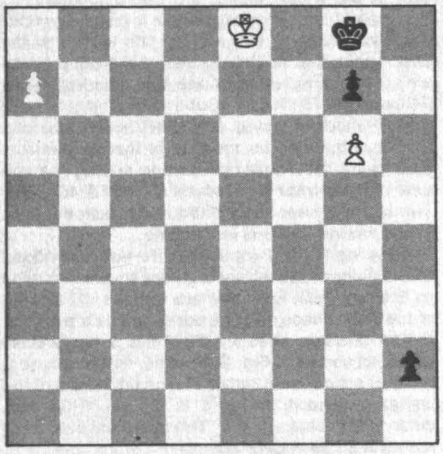
The following solution is from Edgar Rose:

The treasure hunter paced from tree A to the midpoint between trees A and B, made a right turn (90°), paced a distance equal to that between A and the midpoint, stopped, and dug up the treasure.

Proof: place rectilinear coordinates on the map, with tree A at (0,0), and tree B at (B,0). The gallows would have been at any point (a,b). Then following the original instructions, stake A would be at (b, –a) due to the transposition of (a,b) into the clockwise adjacent quadrant. Similarly, but using a transposition into the counterclockwise adjacent quadrant and translation of coordinate origin from (0,0) to (B,0), stake B would be at (B-b, a-B). Since the midpoint between any two points (x_1, y_1) and (x_2, y_2) is $[\frac{1}{2}(x_1 + x_2), \frac{1}{2}(y_1 + y_2)]$, it follows that the treasure is located at (½B, -½B) and its location is independent of a and b.

Also solved by Buzz Karpay, Michael Jung, Steve Feldman, Raymond Gaillard, John Prussing (who points out that he submitted this same problem to Puzzle Corner and we published it in 1975), Richard Hess, Norman Wickstrand, Harry Zaremba, Christian Marchand, Jeff Oehler, Emmet Duffy, Doug Van Patter, Avi Ornstein, John Venti, William Schoenfeld, Winslow Hartford, Winthrop Leeds, and Harry Garber.

FEB 2 White to move and win:



Many people fell into the carefully set trap, but not John Bobbit, who writes:

White has a winning position but he must play carefully.

1. P—R8 (Q) P—R8 (Q)
2. Q—N8!

Both players must queen. White now threatens K—Q7 mate. Note that 2. Q x Q is stalemate. Black can keep this possibility alive by

2. Q—R7
3. Q—Q8

White again threatens K—Q7 mate.

3. Q—R5
4. Q—Q5 ! ck K—R1
5. Q—R8 !

White again threatens K—Q7 mate. But note that Black can no longer force Q x Q stalemate, because the Black king is now in the rook file. Instead

5. Q—R8
6. Q x Q ck K—N1
7. Q—R7 mate

After 2. Q—N8!, Black cannot reply with check. if

2. Q—K5 ck
3. K—Q7

leads to mate, Black cannot work to interpose his queen. If

2. Q—B6
3. K—K7 ck Q—B1
4. Q x Q mate

Any other move by Black, of course, could be met by 3. K—Q7 mate or K—K7 mate. Note that 2. Q—N8! is the only move that works. If

2. Q—Q8 Q—N2

leads to a draw. If

2. Q—B8 Q—R6
3. Q—Q8 Q—K3 ck
4. Q—K7

Black is forced to move

4. Q x Q

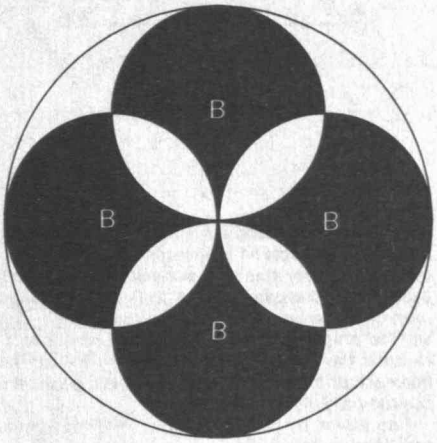
If

2. Q—R2 ck K—R1

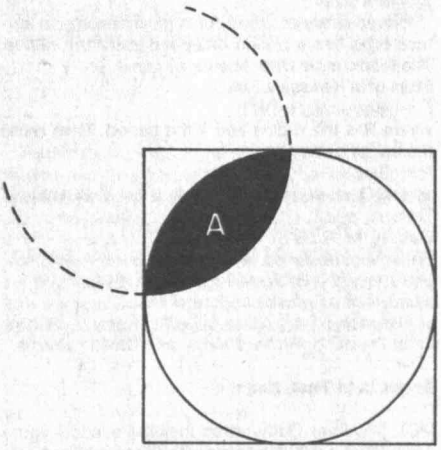
Black will be able to continually check, or trade queens, or position his queen on the first rank. Any of these leads to a draw.

Responses were received from Raymond Gaillard, Richard Hess, Winthrop Leeds, Smith Turner, Steven Killment, Winslow Hartford, George Farnell, Edgar Rose, G. Sharman, T. Burtness, Robert Close, Michael Bercher, Norman Wickstrand, and the proposer, Stuart Schulman.

FEB 3 A trained chimpanzee can hit the patterned dartboard with one out of every two throws, on the average. What is the probability that on a given throw the dart will hit the shaded region?



The following carefully drawn solution is from Buzz Karpay: Let the radius of the large circle be 2, making the radius of a small circle 1.



The area of the intersection of two circles (A) can easily be found:

$A = \pi/4 - (1 - \pi/4) = \pi/2 - 1.$

Thus the area of each of the four dark portions of the dartboard can be expressed as:

$B = \pi - 2(\pi/2 - 1) = 2.$

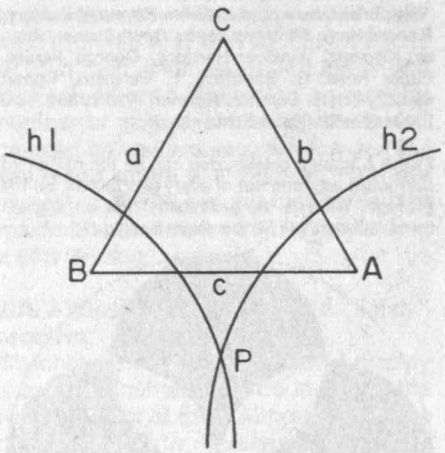
The total shaded area is $4B = 8$, and the area of the large circle is 4π. The percentage of the large circle which is shaded is $8/4\pi = 2/\pi$. Since only every other throw of the dart hits the board, the probability that on a given throw the dart will hit the shaded region is $(2/\pi)/2 = 1/\pi = 0.3183\ldots$

Irl Smith notes that we did not specify the probability distribution of the chimp's throws and presents solutions for several distributions different from the uniform distribution used by Karpay and most other readers. Also solved by Norman Wick-

strand, Winslow Harford, Richard Hess, John Bobbit, Harry Garber, Jeff Oehler, Ken Arbit, Dave Keller, Harry Zaremba, Raymond Gaillard, Marshall Fritz, David Lukeres, Mary Lindenberg, Richard Farber, Paul Mogolesko, Greg Huber, Frank Carbin, Philip Burstein, Michael Jung, and the proposer, John Prussing.

FEB 4 Locate the point P in the plane of a given triangle ABC such that triangles PAB, PBC, and PCA have equal perimeters.

Only Richard Hess found a geometric construction:



Let the sides of triangle ABC satisfy $a \leq b \leq c$. Form the hyperbola h1 intersecting side a and having the property that the distance from h1 to C exceeds the distance from h1 to B by c – b. Next form the hyperbola h2 intersecting side b and having the property that the distance from h2 to C exceeds the distance from h2 to A by c – a. The intersection of these two hyperbolas gives the desired point P.

Also solved by Harry Zaremba, Winthrop Leeds, and Winslow Hartford.

FEB 5 What can be said about the time periods of surface orbits of spheres of the same density but of different sizes?

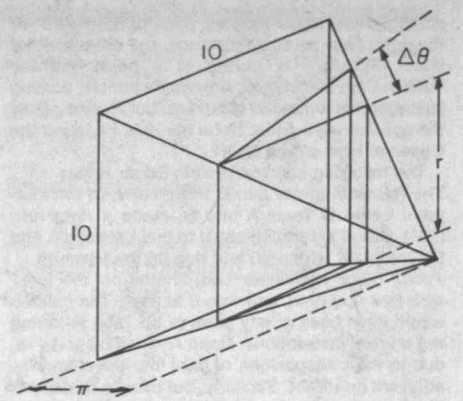
Everyone agrees that, for a given density, a surface orbit has a period independent of the radius. The following is from Michael Jung:
Start with Newton's Law:
$F = ma = m(4R\pi^2)T^2$,
where R is the radius and T the period. Then recall the law of gravitation,
$F = GmdV/R^2$,
where G is constant, d is density, V is volume. Thus
$GdV = 4\pi^2R^3/T^2$.
Since $V = (4/3)\pi R^3$, we obtain
$Gd/3 = \pi/T^2$. Or $T = (3\pi/Gd)^{.5}$
which is clearly independent of R.

Also solved by Emmet Duffy, Harry Zaremba, John Prussing, Richard Hess, and David Lukeres.

Better Late Than Never

OCT 2 Emmet Duffy notes that the second figure given does not quite agree with the one he submitted. As printed the elementary section is shown as a wedge, whereas it should be two parallel r x r squares delta theta apart.

OCT 4 Emmet Duffy, Alan Prince, and a third correspondent whose last name I cannot read note that the published solution is wrong, as it incorrectly generalizes two-dimensional geometry from three-dimensional geometry. Mr. Duffy submitted the following solution. In doing so he notes that this is a "most difficult problem to solve and even more difficult to explain"; he corrected himself twice before sending me the following:
Construct a tetrahedron with four equilateral triangles as faces, with R as the length of each side of a triangle. Then four spheres with radius R can be placed with the center of a sphere at a tetrahedron



vertex and the surface of the sphere will pass through the other three vertices of the tetrahedron. The volume of the tetrahedron will be common to all four spheres and will have a base, $\sqrt{3}\,R^2/4$. The height will be $R\sqrt{2}\sqrt{3}$. Volume is then base times height times $\frac{1}{3} = R^3\sqrt{2}/12 = 0.1178511302R^3$. Additional volume must be added to the tetrahedron to find volume common to all four spheres. Some of it is found by extending outward the planes of any three faces of the tetrahedron so that they intersect the surface of a sphere, forming a spherical triangle. The dihedral angle of a tetrahedron has a cosine equal to ⅓, making the angles 70.52877937°. Each of the three angles of the spherical triangle will be this value, making the sum 211.58633811°. The spherical excess, E, is then the sum of the angles minus 180°, or 31.58633811°. The area of the spherical triangle is given by $\pi R^2E/180$. Multiplying by R/3 will give the volume of the solid angle, that is, the volume of the tetrahedron plus the volume added to one side, totalling $\pi R^3E/540$, or $0.1837618661R^3$. Subtracting the volume of the tetrahedron leaves $0.0659107359R^3$ which is the volume added to one side of the tetrahedron. Multiplying this figure by four and adding the volume of the tetrahedron results in $0.3814940738R^3$. This is the answer I submitted and is also the published answer, but it is incomplete.

Referring to Fig. 2 (opposite), the volumes added to two sides of the tetrahedron are shown in outline as EHF and FJG. Note that two wedges HFI and IFJ of the same shape must be added at all six edges of the tetrahedron. Wedge HFI of Fig. 2 has a base which as shown in Fig. 3 as LMN, which is a segment of a circle with radius R. The tilted side of the wedge, as shown in Fig. 4, is segment PQS of a circle with radius $\sqrt{3}$ R/2. The angle between segments is 35.2644 degrees.

The evaluation of the volume of a wedge will be difficult unless some assumptions are made which will have negligible effect. The base of the wedge is shown in Fig. 5 and the tilted portion in Fig. 6. If a vertical plane in Fig. 5 is passed through the wedge at a distance x from the Y axis, it will intercept AB which is $(R^2 - x^2)^{1/2} - \sqrt{3}$ R/2. Negligible error (less than +2 percent) will be made if it is assumed that the plane makes an intercept of a right triangle with

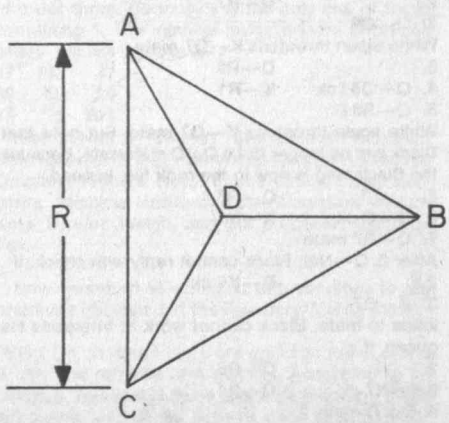


Figure 1: Top view of tetrahedron.

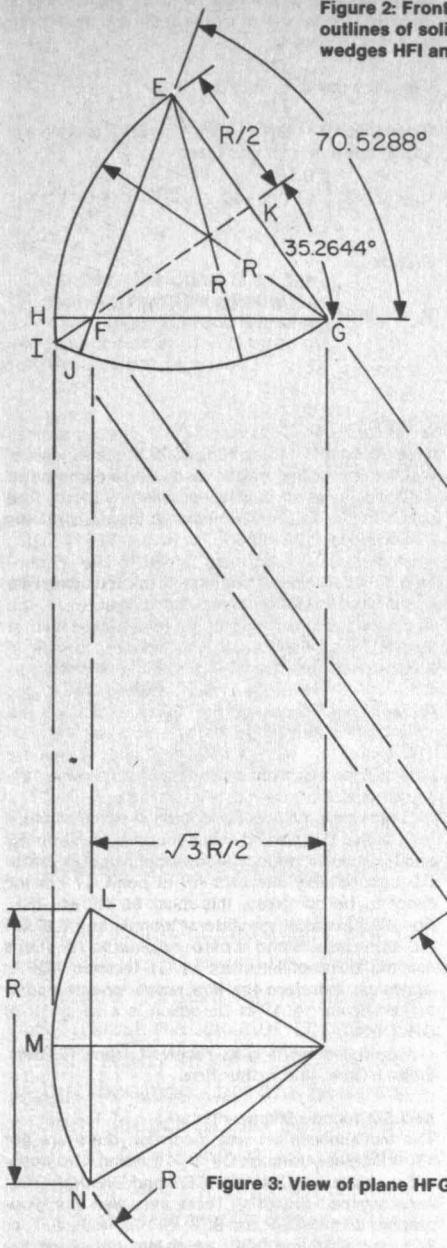


Figure 2: Front view of tetrahedron showing outlines of solid angles EFGJ and GEHF and wedges HFI and IFJ.

$$V = (2 \tan a)/2 \int_0^{0.5R} (AB)^2 dx.$$

As $AB = (R^2 - x^2)^{1/2} - \sqrt{3}\,R/2$, and $\tan a = \sqrt{2}/2$, then:

$$V = \sqrt{2}/2 \int_0^{0.5R} [R^2 - x^2 - \sqrt{3}R(R^2 - x^2)^{1/2} + 3R^2/4]\, dx.$$

From a table of integrals,

$\int (R^2 - x^2)^{1/2} = x/2(R^2 - x^2)^{1/2} + (R^2/2) \arcsin (x/R) + C.$

Then

$$V = \sqrt{2}/2\Big(R^2x - x^3/3 - \sqrt{3}R\Big[(x/2)(R^2 - x^2)^{1/2} + (R^2/2) \arcsin (x/R)\Big]_{x=0}^{x=0.5} + 3R^2x/4\Big)_{x=0}$$

This yields $V = 0.0034531R^3$, and $12V = 0.0414372R^3$, giving a total volume slightly less than $0.42292R^3$.

Figure 3: View of plane HFG.

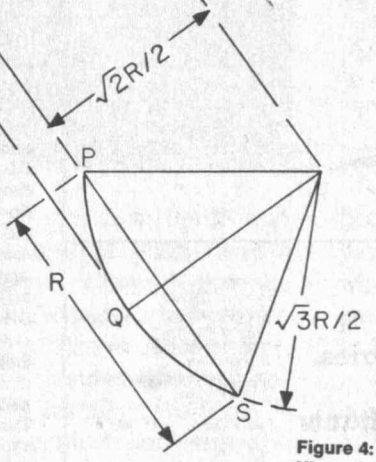


Figure 4: View of plane IFK.

base AB and hypotenuse at an angle 35.2644°. This angle will be called a. This approximation will be slightly more than the correct value.

The triangle with base AB will have height AB tan a and area $(AB^2 \tan a)/2$. Integrating from $x = 0$ to $x = 0.5R$ and multiplying by 2, the volume is given by:

Referring to Fig. 6 below, the volume of the wedge can be approximated, with a value slightly less than correct. A vertical plane is passed through the solid wedge, intercepting the tilted side AB which equals $(3R^2/4 - x^2)^{1/2} - \sqrt{2}R/2$. A slightly-less-than-correct answer will be obtained by assuming that AB is the hypotenuse of a right triangle. The vertical plane will then intercept the wedge forming a right triangle with base ABcos a and

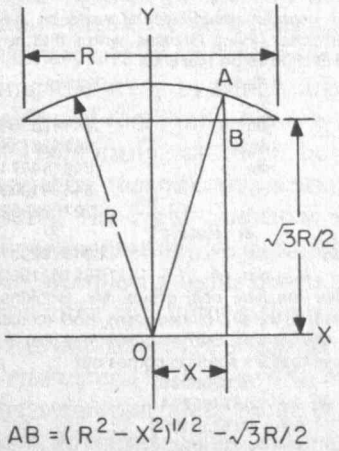


Figure 5.

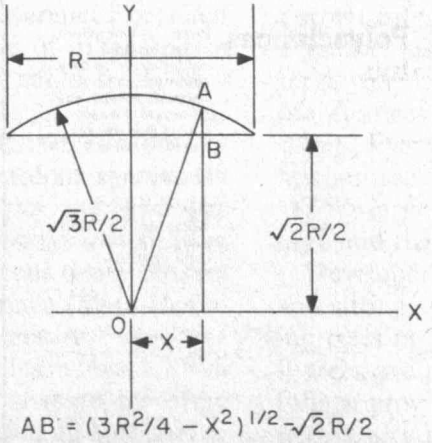


Figure 6.

height ABsin a; its area will be $[(AB)^2 \sin a \cos a]/2$. Integrating from x = 0. to x = 0.5R and multiplying by 2, the volume is

$$V = \sin a \cos a \int_0^{0.5} (AB)^2 dx.$$

Given that $AB = (3R^2/4 - x^2)^{1/2} - \sqrt{2}R/2$ and $\sin a = \sqrt{3}/3$, $\cos a = \sqrt{2}/\sqrt{3}$, then:

$$V = \sqrt{2}/3 \int_0^{0.5R} [3R^2/4 - x^2 - \sqrt{2}R(3R^2/4 - x^2)^{1/2} + R/2]\, dx$$

$$V = \sqrt{2}/3 \left\{ \begin{matrix} 0.5R \\ 3R^2x/4 - x^3/3 - \sqrt{2}R\,[(x/2) \\ (3R^2/4 - x^2)^{1/2} + 3R^2/8(\arcsin \\ 0 \end{matrix} \right.$$

$$\left. \frac{x}{\sqrt{3}R/2} + R^2x/2 \right\}$$

This yields $V = 0.0032650R^3$, and $12V = 0.03918R^3$. Adding to the value already computed, $0.38149R^3$, gives a total of slightly more than $0.42067R^3$. The required volume is thus between $0.42067R^3$ and $0.42292R^3$.

N/D 1 Robert Bart, Eric Backus, and Douglas Fink found shorter solutions. Mr. Bart's are:

	Flip disc	*Othello-instant*
1	D6	C4
2	D3	E6
3	B5	C6
4	D4	C5
5	F5	

N/D 2 Chris Johnson submitted the following improvement:
In his solution, William Schumacher leaves a hole. It is true that CK and FJ intersect as point D on AB and BJ and GH intersect at point E on AC. But does GEH necessarily intersect AB at point C? For the proof to be complete, this must be shown—viz., that AFG forms an equilateral triangle and that GH therefore bisects and is perpendicular to AF. (Let's call the point of intersection L.) Triangle ADF is isosceles; therefore the line which bisects and is perpendicular to AF is DL which is a segment of GH. QED.

Responses were also received from R. Bart, Eugene Sard, and Arthur Poe.

N/D SD 1 John Kellam writes:
The McGuinness list was incorrect; there are not 110 triangles. Although CIP was missing, two duplicates appeared (CKD with CDK and DIG with DGI), reducing the 110 to 109. There were also four typographic errors (DFP for BFP, BFI for BGI, EFI for EGI, and COP for GOP) which did not affect the count. I'm still wondering why Adam Becker, who proposed such a good speed problem, offered a solution with only 79 triangles.

Responses were also received from L. Steffens and Henry Ferguson.

Proposers' Solutions to Speed Problem

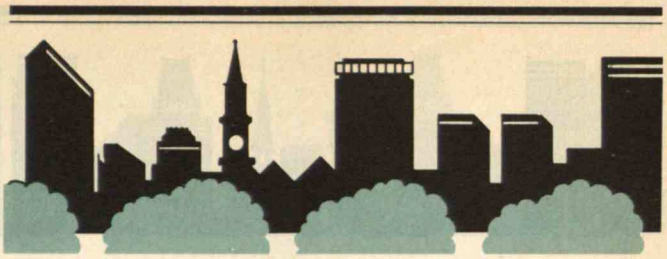
SD2 A programmable calculator can be used, but the proposer, Irving Hopkins, writes that he found his TI-SR50A to be more fun:

Punch	*Display*
1	1
sin	.8414709848
cos	.6663667454
sin	.6181340710
cos	.8149612096
sin	.7276989929
et cetera	
finally, u = sin	.6948196907
v = cos	.7681691567

Besides the (sin, cos) group, Mr. Hopkins finds (sin,tan), (cos,tan), (sin,cos,tan), and (cos,sin,tan) work equally well. But the group (cos,tan) is a surprise, in that the solution comes out

u = .9999060062
v = 1.557085794
u = .0137101028
v = .0137109619

which repeats.



Dinosaurs of Urban Design

The ultimate development in the flight from the street is the urban fortress. In the form of "megastructures," more and more of these things are being put up—huge, multipurpose complexes combining offices, hotels, and shops, such as Detroit's Renaissance Center and Atlanta's Omni International. Their distinguishing characteristic is self-containment. While they are supposed to be the salvation of downtown, they are often some distance from the center of downtown, and in any event tend to be quite independent of their surroundings, which are usually parking lots. The megastructures are wholly internalized environments with their own life-support systems. Their enclosing walls are blank, windowless, and to the street they turn an almost solid face of concrete or brick.

A car is the favored means of entry. At Houston Center you can drive in from the freeway to the center's parking garage, walk through a skyway to one tower, thence to another, work the day through, and then head back

(Continued on next page)

"Unless the plaza is on the way to the subway, why go down into it? Once there, you feel rather as if you were at the bottom of a well."

za in Seattle, the gusts are sometimes so fierce that safety lines must be strung across the plaza to give people something to hang on to. Chicago has the windiest places, not because of the local wind (which isn't really so very much stronger than in other cities), but because the drafts down the sides of the giant John Hancock and Sears towers are macro in force—often so strong as to prevent people from using the plazas, even if they had reason to.

James Marston Fitch, who has done more than any other architect to badger the profession to consider environmental effects, points out that the problem is conceptual, not technical. "Adverse effects are simply ignored," he says, and outdoor spaces are designed as if for some ideal climate, ever sunny and pleasantly warm. Thus [the spaces] fail in their central pretension—that of eliminating gross differences between architectural and urbanistic spaces, of extending in time the areas in which urban life could freely flow back and forth between the two."

Technically, as Fitch points out, we can greatly lengthen the effective season of outdoor spaces. By asking the right questions about sun and wind, by experimentation, we can find better ways to hoard the sun, double its light, obscure it, or cut down breezes in winter and induce them in summer (*See "Rediscovering Energy-Conscious Architecture," August/September 1980, page 68*). We can learn lessons from the semiopen niches and crannies that people often seek. Most new urban spaces are either all outdoors or all indoors; more could be done to encourge in-betweens. With the use of glass canopies or small pavilions, semioutdoor spaces could be created that would be usable in all but the worst weather. They would be particularly appropriate in rainy cities such as Seattle and Portland.

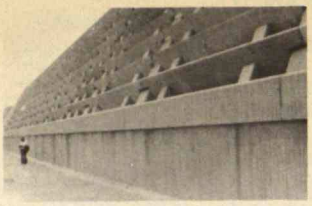
There are all sorts of good reasons for trees, but for climatic reasons alone we should press for many more of them, big ones too, along the sidewalks and open spaces of the city.

Trees ought to be related much more closely to sitting spaces than they usually are. Of the spaces we have studied, by far the best liked are those affording a good look at the passing scene and the pleasure of being comfortably under a tree while doing so. This provides a satisfying enclosure; people feel cuddled, protected—very much as they do under the awning of a street cafe. As always, they'll be cooler, too.

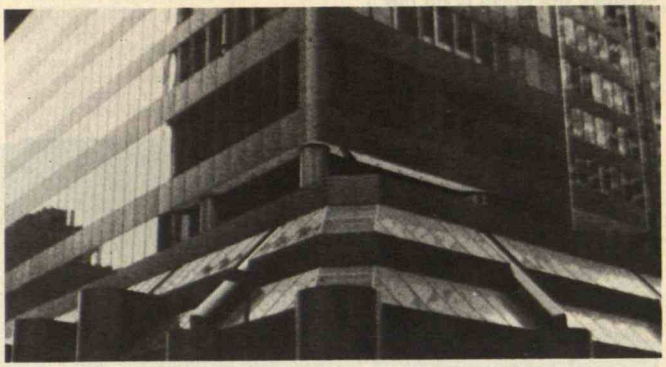
Unfortunately, guy wires and planting beds often serve to rule out any sitting, and even if they don't, the fussiness of design details works to the same effect. Everything is so wired and fenced you can neither get to the tree nor sit on what surrounds it. Where large planters are used, they are generally too high and their rims too narrow for comfort.

Developers should be encouraged to combine trees and sitting spaces. They should also encourage planting trees in groves. As Paley Park has demonstrated, if trees are planted closely together, the overlapping foliage provides a combination of shade and sunlight that is very pleasing. Arbors can do the same.

Water is another fine element, and designers are



Left: The street side of the large concrete wall that flanks the entrance to Detroit's Renaissance Center. Below: The Houston Center, reminiscent of a fortress.



(Continued from page 45)

to the garage and the freeway without ever once having set foot in Houston at all.

There wouldn't be much reason to. Down at the street level of Houston Center there are no store windows. There are no stores. There are not many people. The sole retail activity is a drive-in bank, and the only acknowledgment of pedestrians consists of flashing lights and signs telling them they'd better damn well watch out for cars.

The resemblance to fortresses is not accidental; it is the philosophical base. "Yes, they do look a little forbidding," says one proponent, "but they really have to. The fact is, the only way we can lure middle-class shoppers back to downtown is to promise them security." So, in spirit as well as form, the interstate shopping mall is transplanted to downtown and security raised to the *n*th degree. The complexes abound with guards and elaborate electronic surveillance systems. Any kind of suspicious activity is quickly spotted and attended to (including, as I have found, the taking of photographs). Ports of entry from the city outside are few in number and their design is manifestly defensive. Where Renaissance Center faces Detroit, large concrete walls flank the entrance. The message is clear: afraid of Detroit? Come in and be safe.

The complexes bid to become larger. Increasingly, the megastructures are being combined with convention and sports facilities, which, like megastructures, tend to be located at the edge of downtown or beyond. And these can be mated with other megastructures, via skybridges and con-

doing rather well with it. New plazas and parks provide water in all sorts of forms: waterfalls, waterwalls, rapids, sluiceways, tranquil pools, water tunnels, meandering brooks, fountains of all kinds. In only one major respect is something lacking: access.

One of the best things about water is the look and feel of it. I have always thought that the water at Seagram's looked unusually liquid, and I think it's because you know you can splash your hand in it if you are of a mind to. But in many places water is only for looking at. Let a foot touch it and a guard will be there in an instant: Not allowed. Chemicals in the water. Danger of contamination. If you let people start touching water, you are told, the next thing you know they'll start swimming in it.

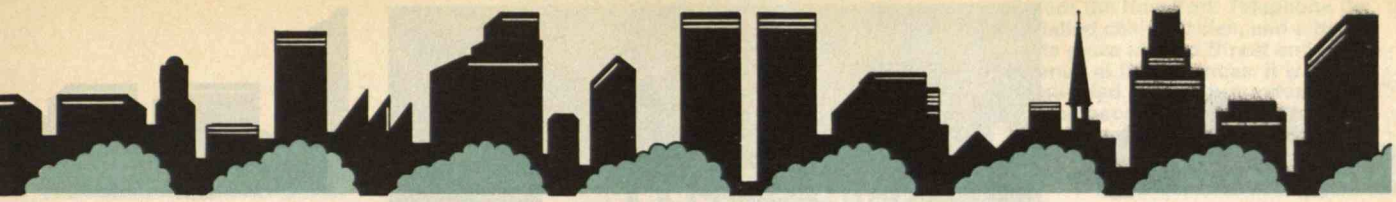
It's not right to put water before people and keep them away from it. But this is what has been happening across the country. Pools and fountains are installed, then immediately posted with signs admonishing people not to touch. Equally egregious is the excessive zeal with which many pools are continually emptied, refilled, vacuumed, and cleaned, as though their primary function was their maintenance.

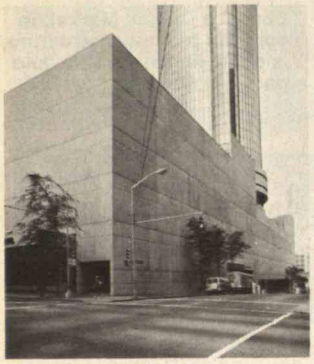
Another great thing about water is the sound of it. When people explain why they find Paley Park so quiet and restful, they always mention the waterwall. In fact, the waterwall is quite loud: the noise level is about 75 decibels close by, measurably higher than the level out on the street. Furthermore, taken by itself the sound is not especially pleasant. I have played tapes to people and asked them what they thought it was. Usually they grimace and say a subway train, trucks on a freeway, or something just as bad. In the park, however, the sound is perceived as quite pleasant. It is white sound and masks the intermittent honks and bangs that are the most annoying aspects of street noise. It also masks conversations. Even though there are many others nearby, you can talk quite loudly to a companion—sometimes you almost have to—and enjoy a feeling of privacy. On the occasions when the waterwall is turned off, a spell is broken, and the place seems nowhere as congenial. Or as quiet.

Eat, Drink and Be Merry

If you want to seed a place with activity, put out food. In New York, at every plaza or set of steps with a lively social life, you will almost invariably find food vendors at the corner and a knot of people around them—eating, shmoozing, or just standing.

Vendors have a good nose for spaces that work. They have to. They are constantly testing the market, and if business picks up in one spot, there will soon be a cluster of vendors there. By default, the vendors have become the caterers of the city's outdoor life. They flourish because they're servicing a demand not being met by the regular commercial establishment. Plazas are particularly parasitic in this respect. Hardly a one has been constructed that did not involve the demolition of luncheonettes and restaurants. Vendors thus fill a void, and this can become quite clear when





courses, to form an almost completely closed circuit. As a result, some American cities now have two cities—regular city and visitor city.

Conventioneers sometimes complain of a lack of variety.

Left: The Peachtree hotel and office complex in Atlanta, which presents this uninviting facade to passersby. Above: The Bonaventure complex in Los Angeles, scaled more to the freeway than to the street.

A logical next step will be the creation within the complexes of facsimiles of streets. There is one at Disneyland, and it is very popular; there are several at the White Flint Mall outside Washington, D.C. With similar showmanship, indoor theme parks could be set up to give an experience of the city without the dangers of it. In addition to such physical features as sidewalks and gaslights, barber poles, and cigar-store Indians, streetlike activities could be programmed, with costumed players acting as street people.

A better approach would be to tie in with real streets in the first place. There are some solid attractions in megastructures—excellent hotels and restaurants, good shops, waterfalls, elevators in glass pods, and public spaces of a drama and luxury not seen since the movie palaces of the twenties. Must isolation be a condition of their attraction? The megastructure thesis is somewhat self-proving. If people go in, it is argued, they must be seeking escape from the city and its insecurities.

But are they? Do people go into Peachtree Plaza Center because there are spikes on its front ledge on Peachtree Street? They went in when there weren't spikes. Do people go into Renaissance Center because of the con-

(Continued on next page)

they are shooed away. A lot of the life of the space goes with them.

New York City is less puritanical than some other places. Many cities have ordinances that not only prevent purveying food outdoors but eating there as well. If you ask officials about this, they tell you of the dreadful things that would happen were the restrictions lifted—of unhealthful food, terrible litter problems, and so on. Partly because of these restrictions, most of the plaza and building complexes constructed during the past ten years have no provision of any kind for outdoor eating. The few that do have had to do some pioneering. The First National Bank of Chicago, for example, found that even to provide such a minimal facility as a popcorn cart they had to get special dispensation from the city.

The most basic facility is a snackbar. Paley and Greenacre parks both have pass-through counters featuring good food at reasonable prices and making a moderate profit. Plenty of tables are provided, and people are welcome to bring their own food—wine, too, if they wish. From the street it sometimes looks like a great big party, and if the line of people for the snackbar gets long passersby will join. Food, to repeat, draws people, and they draw more people.

Where Street and Plaza Meet

Now we come to the key space for a plaza. It is not on the plaza; it is the street. The other amenities we have been discussing are indeed important: sitting space, sun, trees, water, food. But they can be added. The relationship to the street is integral, and it is far and away the critical design factor.

A good plaza starts at the street corner. If it's a busy corner, it has a brisk social life of its own. The activity on the corner is a great show and one of the best ways to make the most of it is simply not to wall it off. A front-row position is prime space, and if it is sittable, it draws the most people.

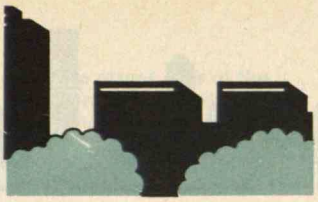
The area where the street and plaza or open space meet is the key to success or failure. Ideally, the transition should be such that it's hard to tell where one ends and the other begins. Paley Park is the best example. The sidewalk in front is an integral part of the park, and an arborlike foliage of trees extends over the sidewalk. There are urns of flowers at the curb and, on either side of the steps, curved sitting ledges. In this foyer you can usually find somebody waiting for someone else—it is a convenient rendezvous point—and people sitting on the ledges, and, in the middle of the entrance, several people in conversations.

Passersby are users of Paley, too. About half will turn and look in. Of these, about half will smile. I haven't calculated a smile index, but this vicarious, secondary enjoyment is extremely important—the sight of the park, the knowledge that it is there, becomes part of the image we have of a much wider area. (If one had to make a cost-benefit study, I think it would show that secondary use provides as much, if not more, benefit than primary use. If one could put a

(Continued on page 47)

crete barriers? Or despite them? The evidence suggests that they go in because there are attractions to enjoy. These attractions do not require separation from the city to be enjoyed and are more enjoyable when not separated. Boston's Faneuil Hall Marketplace is witness to this. It's a bit hokey, shrewdly so, but it's part of a real city and has a splendid sense of place.

This is what megastructures so lack. One feels somewhat disembodied in these places. Is it night or day? Spring or winter? And where are you? You cannot see out of the place. You do not know what city you are in, or if you are in a city at all. The complex could be at an airport or a new town. It could be in the East or the West. The piped music gives no clue. It is the same as it is everywhere. You could be in a foreign country or on a space satellite. You are in a universal controlled environment.



Boston's Quincy Market, in contrast to a megastructure, is open, inclusive, safe, and part of a real city.

And it is going to date very badly. Forms of transportation and their attendant cultures have historically produced their most elaborate manifestations just after they have started to become obsolete. So it may be with megastructures and the freeway era that bred them. They are the last convulsive embodiment of a time passing and a wretched model for the future of the city.—*W.H.W.* □

monetary value on a minute of visual enjoyment and multiply that by those many instances day after day, year after year, one would obtain a rather stupendous sum even after applying a high discount rate.)

The park stimulates impulse use. Many people will do a double take as they pass by, pause, move a few steps, and then, with a slight acceleration, go on up the steps. Watch these flows and you will appreciate how very important steps can be. The steps at Paley are so low and easy that one is almost pulled to them. They add a nice ambiguity to your movement. You can stand and watch, move up a foot, another, and then, without having made a conscious decision, find yourself in the park. The steps at Greenacre Park and Seagram's plaza are similarly low and inviting.

A slight elevation, then, can be beckoning. Go a foot or so higher, however, and usage will fall off sharply. There is no set cutoff level—it is as much psychological as physical—but it does seem bound up with how much of a choice the steps require. One plaza that people could be expected to use, but don't, is only a foot or so higher than two comparable ones nearby. It seems much higher. The steps are constricted in width, sharply defined by railings, and their pitch is brisk. No ambiguity here, no dawdling, no drifting up.

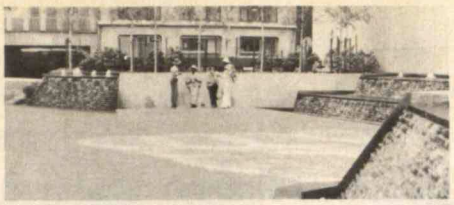
Sightlines are important. If people do not see a space, they will not use it. In the center of Kansas City is a park just high enough above eye level that most passersby do not realize it is there. As a result, it is lost. Similarly lost is a small, sunny plaza in Seattle. It would be excellent and likely quite popular for sitting—if people could see it from the street, which they cannot.

Unless there is a compelling reason, an open space shouldn't be sunk any more than it should be raised. With two or three notable exceptions, sunken plazas are dead spaces. You find few people in them; if there are stores, there are apt to be dummy window displays to mask the vacancies. Unless the plaza is on the way to the subway, why go down into it? Once there, you feel rather as if you were at the bottom of a well. People look at you. You don't look at them.

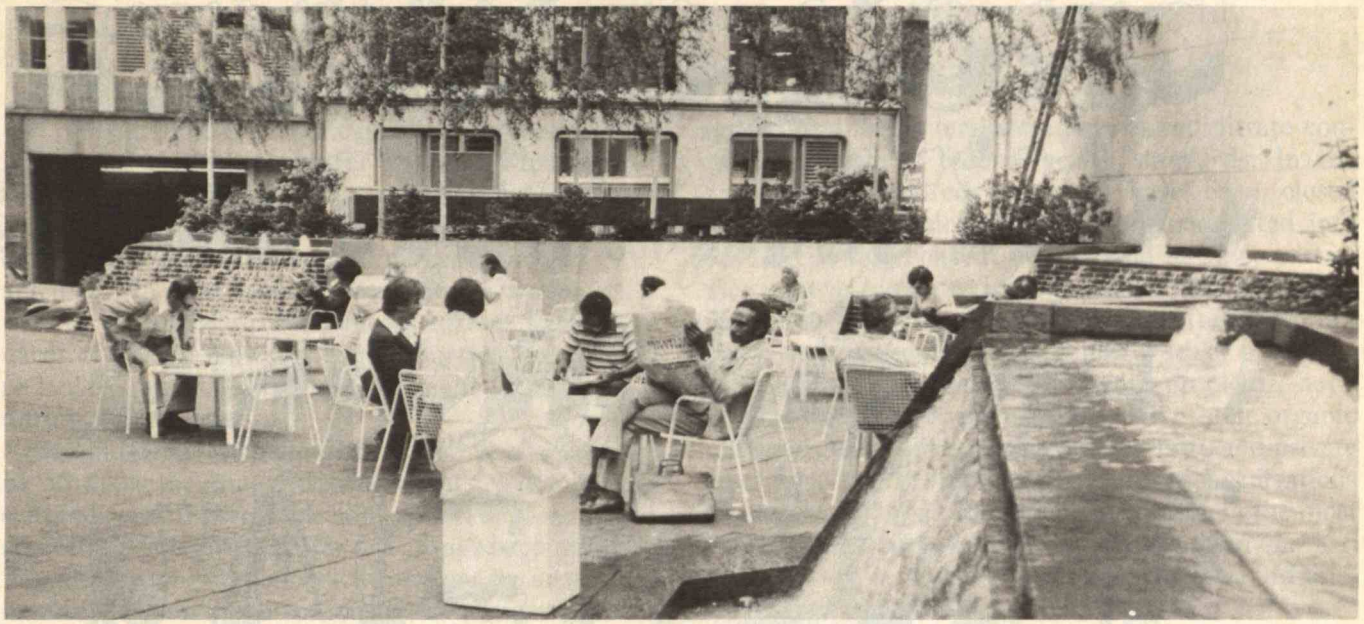
We have gone over the principle factors that make a place work. But there is one more factor. I call it "triangulation." By this I mean that process by which some external stimulus provides a linkage between people and prompts strangers to talk to one another.

The stimulus can be a physical object or sight. At the small park at the Promenade in Brooklyn Heights is a spectacular view of the towers of lower Manhattan across the East River. It is a great conversation opener and strangers normally remark to each other on it. When you come upon such a scene, it would be rude not to.

Sculpture can have strong social effects. Before-and-after studies of the Chase Manhattan plaza showed that the installation of Dubuffet's "Four Trees" has had a beneficent impact on pedestrian activity. People are drawn to the sculpture, and through it; they talk about it. At the Federal Plaza in Chicago, Alexander Calder's huge stabile has had



Before the New York Telephone Co. installed chairs, tables, and a buffet in its plaza at 42nd Street and the Avenue of the Americas, it was frequented mostly by "undesirables." It soon became a success for employees and passersby alike, and most of the undesirables went somewhere else.



similar effects.

Musicians and entertainers draw people together. Rockefeller Plaza and the First National Bank of Chicago regularly schedule touring school bands, rock groups, and the like. And the real show is usually the audience. Many people will be looking as much at one another as at what's on stage.

It is not the excellence of the act that is important. It is the fact that it is there that bonds people, and sometimes a really bad act will work even better than a good one. Street entertainers, for example, can run the gamut from very, very bad to sublime, but the virtue of street acts is their unexpectedness. When people form a crowd around an entertainer—it happens very quickly, in 40 to 50 seconds—they look much like children who have come upon a treat; some will be smiling in simple delight. These moments are true recreation, though they are rarely thought of as such, certainly not by the retailers who try so hard to outlaw them. But there is something of great value here, and it should be fostered.

Why not invite entertainers onto a plaza instead of banning them? One corporation is considering a plan to welcome the best of the street entertainers to its new building. They would be given the equivalent of several good collections for doing their act.

Most of the elements that induce the triangulation effect are worthwhile in their own right. Simply on aesthetic grounds, Dubuffet's "Four Trees" much improves the scale and sense of place in the Chase Manhattan plaza. But the social effects are important. By observing them, we can find how they can be anticipated and planned.

I am not, by the way, arguing for places of maximum gregariousness or social directors for plazas. Anomie would be preferable. What I'm suggesting, simply, is that we make places friendlier. We know how—in both the design and management of spaces, there are many ways to make it much easier for people to mingle and meet. Some of the most felicitous spaces have been provided inadvertently. Think what might happen if someone planned them.

It is wonderfully encouraging that places people like best of all, that they find least crowded and most restful, are small spaces marked by a high density of people and very efficient use of space.

I end, then, in praise of small spaces. The multiplier effect is tremendous. It is not just the number of people using them but the larger number who pass by and enjoy them vicariously, or the even larger number who feel better about the city center for knowledge of them. For a city, such places are priceless. Yet they are built on a set of basics that are right in front of our noses. If we will look. □

William H. Whyte is director of the Street Life Project in New York City. This article is based on research conducted by that group since 1971 and is excerpted from his book *The Social Life of Small Urban Spaces* (the Conservation Foundation, Washington, D.C., 1980). Among his other books are *The Organization Man, Open Space Action, Cluster Development,* and *The Last Landscape.*

The editors acknowledge the *NOVA* program "City Spaces, Human Places" (originally broadcast on PBS November 29, 1981), which served as inspiration for this article.

GROUNDWATER CONTAMINATION: AN EMERGING THREAT

Synthetic organic chemicals are contaminating groundwater in many parts of the nation, possibly posing unacceptable risks to human health.

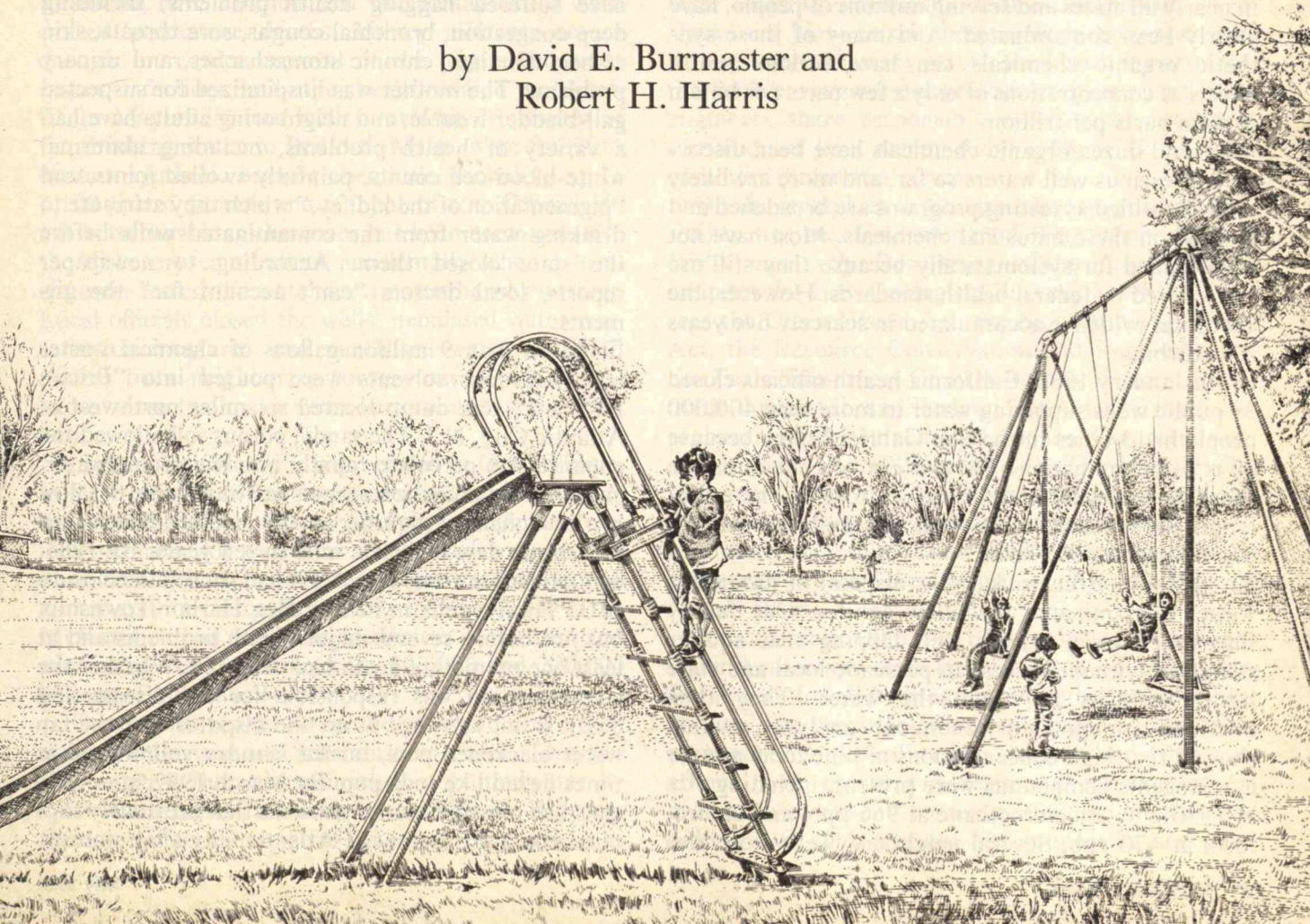
by David E. Burmaster and Robert H. Harris

ABOUT half of all Americans rely on groundwater, much of it untreated, for drinking. More generally, groundwater supplies one-quarter of the fresh water used for *all* purposes in the nation—and the use of ground water increased 140 percent between 1950 and 1975. In most regions, groundwater within half a mile of the surface readily meets current legal standards of purity. However, contamination does occur, and alarming new pollutants have been discovered during the last few years.

Groundwater, the volume of which is estimated to be 50 times the annual flow of surface water, is present in layers of permeable soil, gravel, or stone called aquifers. Some groundwater has always been unfit for human consumption or agricultural use because of its naturally high mineral content. Groundwater has also frequently been spoiled by some "traditional" pollutants from human activities. For example, in many agricultural areas, fertilizers have raised nitrate concentrations above federal health standards. In the Snow Belt, hundreds of wells have been closed because highway deicing salts have percolated into aquifers in high concentrations. And in every part of the country, some private and public wells have been contaminated by bacteria and viruses, often the product of malfunctioning septic tanks or leaky pipes.

More insidious than any of these problems, however, are the high concentrations of synthetic organic chemicals now found in many community and private drinking-water wells. In some places, concentrations are orders of magnitude higher than those in the most contaminated surface supplies, among them the Kanawha River in West Virginia and the lower Mississippi River in Louisiana.

For example, before state officials closed them, several wells in Pennsylvania, New York, and New Jer-



Strict land-use controls are the most reliable tools for effective management of groundwater quality.

sey contained more than 1,000 parts per billion (ppb) of trichloroethylene, or TCE, a widely used industrial solvent and degreaser known to cause cancer in laboratory mice; the concentration in one well was 27,300 parts per billion. As late as 1980, the highest TCE concentration ever reported in a surface supply of drinking water was 160 parts per billion. In Tennessee, several wells, now closed, are contaminated by more than 100,000 parts per billion of carbon tetrachloride, another carcinogen. Until 1980, the highest known concentration of this chemical in a surface water supply was 30 parts per billion.

Total Danger Unknown

No one can say how long groundwater has been contaminated by synthetic chemicals, what exposures people have sustained, or what health effects, if any, have been suffered, because the discoveries are so recent that no comprehensive national data exist. However, hundreds of drinking-water wells, located in nearly all states and serving millions of people, have clearly been contaminated. And many of these synthetic organic chemicals can have serious health effects at concentrations of only a few parts per billion or even parts per trillion.

Several dozen organic chemicals have been discovered in various well waters so far, and more are likely to be identified as testing programs are broadened and focused on these industrial chemicals. Most have not been looked for systematically because they still are not covered by federal health standards. However, the anecdotal evidence accumulated in scarcely five years is disturbing:

☐ In January 1980, California health officials closed 39 public wells supplying water to more than 400,000 people in 13 cities in the San Gabriel Valley because of TCE contamination. The pattern of contamination suggests multiple, widespread sources of the pollutant. The TCE concentration at one well, now closed, was 600 parts per billion.

☐ In South Brunswick, N.J., disposal of hazardous wastes contaminated a shallow aquifer. One family that relied on a private well tapping that aquifer struggled without success to persuade local and state health officials to check the water. They then obtained independent chemical analyses, which showed that high concentrations of nine toxic and/or carcinogenic compounds were present, including TCE at 1530 ppb, trichloroethane at 965 ppb, and chloroform at 420 ppb. Several neighbors' wells were also badly contaminated.

☐ Rocky Mountain Arsenal, jointly operated by the U.S. Army Chemical Corps and Shell Chemical Co., is located between Denver and Brighton, Colo. The facility was used to dispose of complex chemical by-products, from the manufacture of pesticides and herbicides, in unlined holding ponds. This practice led to infiltration into a shallow aquifer and subsequent migration of contaminants through groundwater. Although the practice was discontinued, 30 square miles of the aquifer have been contaminated, forcing a number of domestic, stock, and irrigation wells to be abandoned.

☐ In late 1979, state health officials began closing private wells in Lake Carmel, N.Y., because the water contained organic chemicals, including benzene, a known cause of leukemia. By April 1981, 32 wells had been closed. One young couple whose well was declared unfit for drinking in August 1979 continued to use the water for other household purposes. The couple's four children, each then under five years old, have suffered nagging health problems, including deep congestion, bronchial coughs, sore throats, skin rashes, diarrhea, chronic stomachaches, and urinary problems. The mother was hospitalized for suspected gall-bladder trouble, and neighboring adults have had a variety of health problems, including abnormal white-blood-cell counts, painfully swollen joints, and "pigmentation of the kidney," which they attribute to drinking water from the contaminated wells before the state closed them. According to newspaper reports, local doctors "can't account for" the ailments.

☐ More than 9 million gallons of chemical wastes and hazardous solvents were poured into "Price's Pit," a 22-acre dump located six miles northwest of Atlantic City, N.J. The sandy, porous soil allowed the chemicals to percolate rapidly into the groundwater, and the contamination seeped eastward with the flow of the Cohansey Aquifier at the rate of about seven inches per day, or half a mile in ten years. By 1981, contamination from Price's Pit had caused the closure of 35 family wells in nearby Egg Harbor Township, but not before several major health problems and at least one premature death had occurred. Whether the contamination was responsible for the disease and death is not known, but no one disputes that the tap water blackened pots, turned laundry yellow, and at times fizzed like soda pop. By March 1982, state officials had closed 7 municipal wells that previously supplied about 40 percent of Atlantic City's tap water.

Hundreds of drinking-water wells, located in nearly all states and serving millions of people, have clearly been contaminated.

☐ In 1972, a landfill in Jackson Township, N.J., was licensed by the state to accept sewage sludge and septic-tank wastes. (The landfill abuts the Ridgeway Branch of the Toms River and overlies the Cohansey Aquifer, the town's sole source of drinking water.) Since then, some one hundred drinking-water wells around the landfill have been closed because of contamination by organic chemicals that were apparently dumped illegally. Analysis of some well water showed severe contamination by toluene at 6,400 ppb, methylene chloride at 3,000 ppb, acetone at 3,000 ppb, ethyl benzene at 2,000 ppb, TCE at 1,000 ppb, benzene at 330 ppb, and chloroform at 33 ppb. Residents have claimed that the contaminants have caused premature deaths, kidney ailments severe enough to require removal of the organ, recurrent rashes, infections, and other health-related problems.

☐ In May 1978, four wells providing 80 percent of the drinking water to Bedford, Mass., were found to contain synthetic organic chemicals, including up to 2,100 ppb of dioxane and 500 ppb of TCE. Officials do not know how long the water has been contaminated; the discovery came about accidentally when a local engineer tested the water for a paper he was writing. Local officials closed the wells, mandated water-conservation measures, and purchased water (at retail prices) from neighboring towns—one of which also had to close two major wells because of TCE contamination.

☐ Sixteen private wells were closed in Gray, Maine, in 1977 because of contamination by trichloroethane, TCE, freon, acetone, xylene, dimethyl sulfide, and various alcohols. All were near an industrial-waste handling facility built in 1972 to process waste oil from a tanker spill in Casco Bay. From then until 1977, the McKin Co. had used the facility as a transfer and processing station for between 100,000 and 200,000 gallons of oil annually.

These cases represent rural, suburban, and urban areas in industrial and nonindustrial states. Together they suggest that contamination of groundwater by synthetic organic chemicals is widespread. Whether the data reflect the range of water-quality problems is not known because in almost every case, only a few of several hundred possible compounds were tested for—and then only when contamination was already suspected. In some areas, further analyses have shown high concentrations of synthetic chemicals not looked for the first time.

Governmental Footdragging

State and federal agencies have taken action slowly to deal with this threat, and the overall statutory protections against toxic organic chemicals in drinking water are slim. Every state now has at least one law pertaining to some types of groundwater contamination—but not necessarily contamination by toxic organic chemicals—with Connecticut, New York, and New Jersey the leaders in protection and management. In many states, the health department, the state environmental protection agency, and state engineers share responsibility—with the attendant confusion of joint responsibility—for drinking water and other groundwater uses.

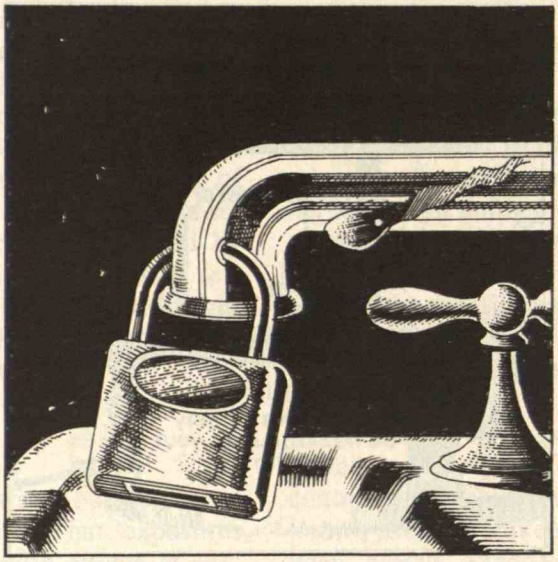
On the federal level, Congress has assigned responsibility to the Environmental Protection Agency (EPA) and to the Department of the Interior, which includes the U.S. Geological Survey. The EPA oversees the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Toxic Substances Control Act, the Federal Insecticide, Fungicide, and Rodenticide Act, and the Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund"). The Interior Department carries out the Surface Mining Control and Reclamation Act. These federal laws overlap in parts, leading to some duplication of effort, and they do not cover every threat, even with state efforts to back up federal efforts.

In November 1980, the EPA proposed a "groundwater protection strategy" to serve as the policy framework for all its programs affecting groundwater quality. The proposed strategy included management approaches for coordinating groundwater protection efforts, and provided background information on groundwater use and contamination and on state and federal laws. This strategy also proposed a new part-

As a first step, the nation must have legal standards for many toxic organic chemicals found in drinking water.

nership between state and federal agencies in understanding and preventing contamination.

However, with the appointment of Anne Gorsuch as EPA administrator in May 1981, the Reagan administration quietly blocked the proposed strategy, and has, de facto, turned over all responsibility for managing groundwater quality to the states. In September 1981, Representative Toby Moffett (D-Conn.), chairman of the Environment, Energy, and Natural Resources Subcommittee of the House Committee on Government Operations, wrote Ms. Gorsuch asking her to complete the proposed strategy as soon as possible. However, she has made little or no response to this request, although a "task force" on groundwater contamination has been established inside the agency.



Underground Activity

Water reaches an aquifer through one or several recharge zones, relatively permeable areas in a surface-water drainage basin where the net flow of water is directed into the earth. Recharge to a shallow-water-table aquifer may occur through all the soils and materials above, or only at discrete, highly permeable areas. Streams, lakes, and wetlands commonly mark a hydrologic connection between surface water and groundwater. Water from shallow aquifers sometimes percolates into deeper aquifers confined between layers of relatively impermeable rock. This recharge may occur at some distance from the water's starting point at the surface.

Shallow groundwater is usually pure because soils and soil microbes remove most "traditional" pollutants as water seeps down from the surface. Also, minor cleansing occurs through filtration and adsorption as the water moves vertically and horizontally through an aquifer. However, these processes do not eliminate most synthetic organic chemicals. For example, soil microorganisms for all practical purposes do not break down many chlorinated hydrocarbons such as PCBs. Moreover, very little, if any, further cleansing takes place once water reaches the chemically reduced, abiotic, cool, and dark region of a deep aquifer. Thus, once contaminated, groundwater may remain so for hundreds or thousands of years, if not for geologic time.

The quality of water in an aquifer depends not only on the quality of water percolating down from the surface, but also on the area's particular geologic and hydrologic conditions. For example, a municipal or hazardous-waste landfill sited on a thick layer of natural clay may pose relatively little threat to an aquifer below, but one sited on permeable material is a serious threat. Therefore, strict land-use controls at the recharge areas of an aquifer are the most reliable tools for effective management of groundwater quality. Because human activities—homes, roads, industry, and waste-disposal facilities—significantly affect the quality of water recharging an aquifer, government policies should reflect this important link.

Culprits in Contamination

According to the EPA, industrial waste and municipal sites for disposal of solid waste are the biggest threats to groundwater quality, particularly in the Northeast, Southeast, and Northwest. For example, approximately 60 million tons of liquid and solid industrial hazardous wastes were disposed of in 1978, mostly in landfills or lagoons that do not meet new federal standards. Other important contamination sources include septic tanks, municipal wastewater, underground waste-injection wells, mines, and petroleum and natural-gas production facilities, which can cause significant regional problems.

Although the data are not firm, the EPA estimates that there are 75,700 active landfill sites for industrial wastes. Some 50,650 active and inactive sites may have potentially dangerous amounts of hazardous substances. The Surface Impoundment Assessment survey, funded by the EPA and conducted by the states in the late 1970s, has identified 10,819 industrial-waste disposal sites for special analyses. Of the 8,163 sites examined by 1981, half hold liquid wastes that may contain hazardous substances, and 70 percent

have no bottom lining, possibly allowing contaminants to escape. Most disturbing, 10 percent of the impoundments are unlined, located in geologic settings that allow free downward movement of any liquid, and within one mile of a drinking-water well. Only 5 percent of all the sites have systems for monitoring groundwater quality.

Tests confirm that many industrial landfills do indeed contaminate groundwater. A 1977 EPA study of 50 disposal sites found organic chemicals—including PCBs, chlorinated phenols, benzene and its derivatives, and organic solvents—in the groundwater at 40 sites and migration of the chemicals at 27 sites. Heavy metals were found at 49 sites and had migrated at 40. Selenium, arsenic, or cyanide was present at 37 and had migrated at 30.

For the other major source of contamination nationwide—municipal landfills—a survey by *Waste Age* magazine identified approximately 16,000 active sites, only 35 percent of which were in compliance with state regulations as of 1976. The number of abandoned or closed municipal dumps and landfills is not known but could be comparable.

Septic tanks and cesspools rank highest in the total volume of wastewater—more than a trillion gallons a year—discharged from them directly into groundwater, and are the most frequently reported sources of bacterial and viral contamination. Approximately 19.5 million houses in the United States have their own sewage disposal systems. Where septic tanks are favored—in the Northeast and California, for example—contamination of groundwater has been documented. The problem is magnified by the fact that in many areas—especially rural communities—the prevalence of septic tanks is paralleled by reliance on private wells for drinking water.

A septic tank with a soil absorption field provides low-cost, reliable treatment for normal household wastewater if properly sited, designed, built, and operated. Every few years, the sludge and greasy scum that accumulate in the tank must be removed, usually by a large suction unit mounted on a truck. Otherwise, the bottom sludge or scum may overflow and clog the absorption field, increasing the possibility of contaminating the groundwater. However, to reduce the frequency of these costly cleanings, many homeowners buy do-it-yourself septic-tank cleaning fluids, which usually contain TCE, benzene, or methylene chloride. Flushing a gallon or less of such a cleaner down a toilet mobilizes the scum and sludge so they will not clog the soil absorption field.

But there are two serious problems with this approach. The sludge itself is a contaminant, and worse, TCE and benzene, both known carcinogens, flow into the groundwater. An estimated 400,000 gallons of septic-tank cleaners were used by homeowners in 1979 on Long Island alone, causing widespread groundwater contamination and the closing of many public and private drinking-water wells.

In many of the nation's mining areas, polluted groundwater is an accepted fact of life. Contamination is caused not only by waste-disposal facilities, such as slurry lagoons, tailings ponds, and slag piles, but also by the failure to reclaim mined land. Moreover, the national effort to develop synthetic fuels—for example, gas or liquid fuels from coal or shale—could threaten groundwater quality unless adequate protection accompanies their development. In particular, underground (in situ) retorting of oil shale without proper safeguards can easily cause groundwater contamination.

Oil production has caused substantial contamination in at least 17 of the South-Central and Southwestern states. The EPA has identified nearly 65,000 active impoundments from oil production, and in Texas alone, 23,000 cases of groundwater and surface-water contamination have been linked to the oil industry. Although brine pits to dispose of the saline by-products of drilling are now almost universally banned by the states, groundwater use has had to be restricted in many places. Abandoned and poorly maintained production and injection wells are also potential sources of contamination.

Measuring Contamination: Problems and Progress

It is extremely difficult to learn how much contamination these and other activities cause. Groundwater moves slowly, generally just a few tens of feet per year. Chemicals leaching from a contamination site such as a landfill will disperse into a plume, the dimensions of which are determined by the aquifer's structure. Eventually contaminants can move great distances, but because of the vagaries of speed, flow, and dispersion, groundwater may be heavily contaminated in one place and pristine only a few hundred feet away. Furthermore, it may take decades for groundwater polluted in one place to appear in a water supply elsewhere.

Also, monitoring these sites is expensive, with a single test well costing upwards of $10,000. When groundwater contamination occurs in multiple layers

Many synthetic organic chemicals can have serious health effects at concentrations of only a few parts per billion.

between confining rock strata, several isolated wells are needed. In fact, many wells are necessary to locate and assess the rate of travel of a contamination plume in most aquifers. Further assessment of quality requires sophisticated and expensive instruments, and measurements must be repeated regularly to follow migration.

To gain a national perspective on the extent and severity of groundwater and drinking-water contamination, the Council on Environmental Quality (CEQ) compiled data during 1980 from the EPA Office of Drinking Water, several states, and the ten EPA regions. Although even a composite profile from these sources would fall short in depth, breadth, and accuracy, this survey provides the most comprehensive evidence available.

In the EPA study begun in 1975, the Office of Drinking Water studied 39 cities relying on groundwater. Most had populations between 10,000 and 1 million, and they were not chosen with regard to potential groundwater contamination. Eleven volatile chlorinated hydrocarbons were present frequently and sometimes in high concentrations in both raw (untreated) and treated drinking water: TCE, carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, trans-dichloroethylene, cis-dichloroethylene, 1,1-dichloroethylene, methylene chloride, and vinyl chloride. TCE and tetrachloroethylene, similar chemical carcinogens, were found most often.

Some states have vigorous testing programs for a few synthetic organic chemicals in drinking-water wells. As of March 1980, agencies in 18 states had measured organic compounds in water from 2,894 wells. The contaminant concentrations they reported were generally higher than in the 39 cities that the EPA surveyed, perhaps because most of the states focused on "hot spots." Again, TCE was most common, and other chlorinated hydrocarbons—tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethane, and dichloroethylene—were also found consistently, some in concentrations above 1,000 parts per billion.

Michigan, Massachusetts, and New York have compiled the most thorough reports of their findings. Michigan's report, a 1979 survey of all counties, identified 268 contaminated sites (83 percent by hazardous substances, oil, or gas), 381 sites where groundwater contamination is suspected, and more than 50,000 sites where a potentially polluting activity either takes place or has taken place. For the 268 proven sites alone, Michigan estimates that tests to determine the extent of the pollution will cost from $12.9 million to $46.1 million.

The Massachusetts report, released in September 1979, states that "at least one-third of the Commonwealth's [351] communities have been affected to some degree by chemical contamination." Private and public wells have been restricted or closed in 22 towns. In Groveland and Rowley, all municipal wells have been closed because of TCE contamination. In North Reading, TCE concentrations exceeded 900 parts per billion in two wells supplying nearly a third of the town's water. (The state's allowable maximum contaminant level for TCE is 10 parts per billion.) Since publication of the report, wells in other parts of the state have been closed.

According to New York's report published in 1980, the state first learned in 1976 that some wells in Nassau County on Long Island were severely contaminated by synthetic organic chemicals. State and county agencies then analyzed every community drinking-water well in the county for six synthetic organic chemicals: tetrachloroethylene, TCE, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, and trifluorotrichloroethane. The first three chemicals were present in more than 10 percent of the wells in maximum concentrations of 375 ppb, 300 ppb, and 67 ppb, respectively. The state also sampled wells in Suffolk County at about the same time. By December 1978, 23 community water wells in Nassau County and 13 in Suffolk County (out of 500 total) were closed, affecting more than 2 million people.

In 1978, the New York State Health Department and the U.S. Geological Survey began testing groundwater elsewhere in the state for 112 organic chemicals. Thirty public water systems—a total of 39 wells—were sampled, and all were polluted. The industrial chemicals bis(2-ethylhexyl)phthalate, toluene, and di-n-butyl phthalate were found in 92, 85, and 54 percent, respectively, of the wells sampled.

The most complete portrait of groundwater contamination comes from the EPA's regional offices. In the spring of 1980, the CEQ asked each EPA region to assemble information on the magnitude of groundwater contamination, the number of wells closed, and the quality and abundance of available data, as well as public-health statistics that might indicate injurious effects. The results revealed that drinking water is contaminated in 34 states, and there are indications that the true number is at least 40. Nearly every state east of the Mississippi, and even nonindustrial, lightly

Synthetic organic compounds commonly found in drinking water wells

The concentrations of these chemicals in groundwater are considerably higher than those found in surface supplies. Nearly every state east of the Mississippi—and even nonindustrial, lightly populated Western states such as Idaho, Arizona, and New Mexico—report major problems.

Chemical	Highest concentrations (ppb)	State	Highest surface water concentration reported (ppb)
Trichloroethylene (TCE)	27,300	Pennsylvania	160
	3,800	New York	
	1,530	New Jersey	
	900	Massachusetts	
Toluene	6,400	New Jersey	6.1
1,1,1-Trichloroethane	5,440	Maine	5.1
	5,100	New York	
	1,600	Connecticut	
	965	New Jersey	
Acetone	3,000	New Jersey	NI*
Methylene chloride	3,000	New Jersey	13
	47	New York	
Dioxane	2,100	Massachusetts	NI
Ethyl benzene	2,000	New Jersey	NI
Tetrachloroethylene	1,500	New Jersey	21
	740	Connecticut	
	717	New York	
Cyclohexane	540	New York	NI
Chloroform	490	New York	700
	420	New Jersey	
Di-n-butyl-phthalate	470	New York	NI
Carbon tetrachloride	400	New Jersey	30
	135	New York	
Benzene	330	New Jersey	4.4
	70	Connecticut	
	30	New York	
1,2-Dichloroethylene	323	Massachusetts	9.8
	91	New York	
Ethylene dibromide (EDB)	300	Hawaii	NI
	35	California	
Xylene	300	New Jersey	24
	69	New York	
Isopropyl benzene	290	New York	NI
1,1-Dichloroethylene	280	New Jersey	0.5
	118	Massachusetts	
	70	Maine	
1,2-Dichloroethane	250	New Jersey	4.8
Bis (2-ethylhexyl) phthalate	170	New York	NI
DBCP (Dibromochloropropane)	137	Arizona	NI
	95	California	
Trifluorotrichloroethane	135	New York	NI
Dibromochloromethane	55	New York	317
	20	Delaware	
Vinyl chloride	50	New York	9.8
Chloromethane	44	Massachusetts	12
Butyl benzyl-phthalate	38	New York	NI
gamma-BHC (Lindane)	22	California	NI
1,1,2-Trichloroethane	20	New York	NI
Bromoform	20	Delaware	280
1,1-Dichloroethane	7	Maine	0.2
alpha-BHC	6	California	NI
Parathion	4.6	California	0.4
delta-BHC	3.8	California	NI

*NI = not investigated

OMNIGRAPHICS

Common drinking-water contaminants tested to date by the National Cancer Institute. Most proved carcinogenic in at least one animal species, and two chemicals are known to be human carcinogens.

Selected synthetic organic chemicals detected in drinking water wells

Chemical	Evidence for carcinogenicity
Benzene	H
alpha-BHC	CA
gamma-BHC (Lindane)	CA
Carbon tetrachloride	CA
Chloroform	CA
Dibromochloropropane (DBCP)	CA
1,1-Dichloroethane	SA
1,2-Dichloroethane	CA
Dioxane	CA
Ethylene dibromide (EDB)	CA
Parathion	SA
Tetrachloroethylene	CA
1,1,1-Trichloroethane	NA
1,1,2-Trichloroethane	CA
Trichloroethylene (TCE)	CA
Vinyl chloride	H, CA

H = Confirmed human carcinogen
CA = Confirmed animal carcinogen
NA = Negative evidence of carcinogenicity from animal bioassay
SA = Suggested animal carcinogen

populated Western states such as Idaho, Arizona, and New Mexico, reported major problems.

Thirty-three synthetic organic contaminants were reported most frequently (*see the table on page 57*). The most prevalent contaminants are chlorinated solvents such as TCE, trichloroethane, tetrachloroethylene, trifluorotrichloroethane, 1,1-dichloroethylene, 1,2-dichloroethylene, chloroform, and carbon tetrachloride. And the concentrations of these chemicals in groundwater are considerably higher than those found in surface drinking-water supplies.

While bringing to light an important national environmental problem, these studies also highlight the gaps in our knowledge. Several more thorough studies now in progress should help document the dimensions of the threat to groundwater. The EPA's Office of Drinking Water has almost completed a survey of volatile organic contaminants in 333 small-community water supplies served by groundwater. The EPA has also nearly finished surveying about 900 groundwater supplies for rural households. And finally, the EPA and the states have just begun to sample a thousand sites to determine the geographical extent of drinking-water-well contamination, again focusing on small community systems, with half the sites selected randomly and half because chemical contamination is suspected.

Health Risks of Contaminants

People have alleged health damages ranging from skin rashes to cancer in several locations where groundwater is badly contaminated. Unfortunately, these alleged effects have not been rigorously evaluated. In fact, retrospective studies may never be conclusive because of inadequate data and small sample sizes. Nonetheless, this anecdotal information raises legitimate questions about the acute, subacute, and chronic effects that might result from drinking contaminated groundwater.

Predicting the likelihood of disease resulting from exposure to these contaminants also is hampered by sparse data. Still, rough estimates can be made based on evidence from occupational exposures, epidemiological studies, and animal laboratory tests.

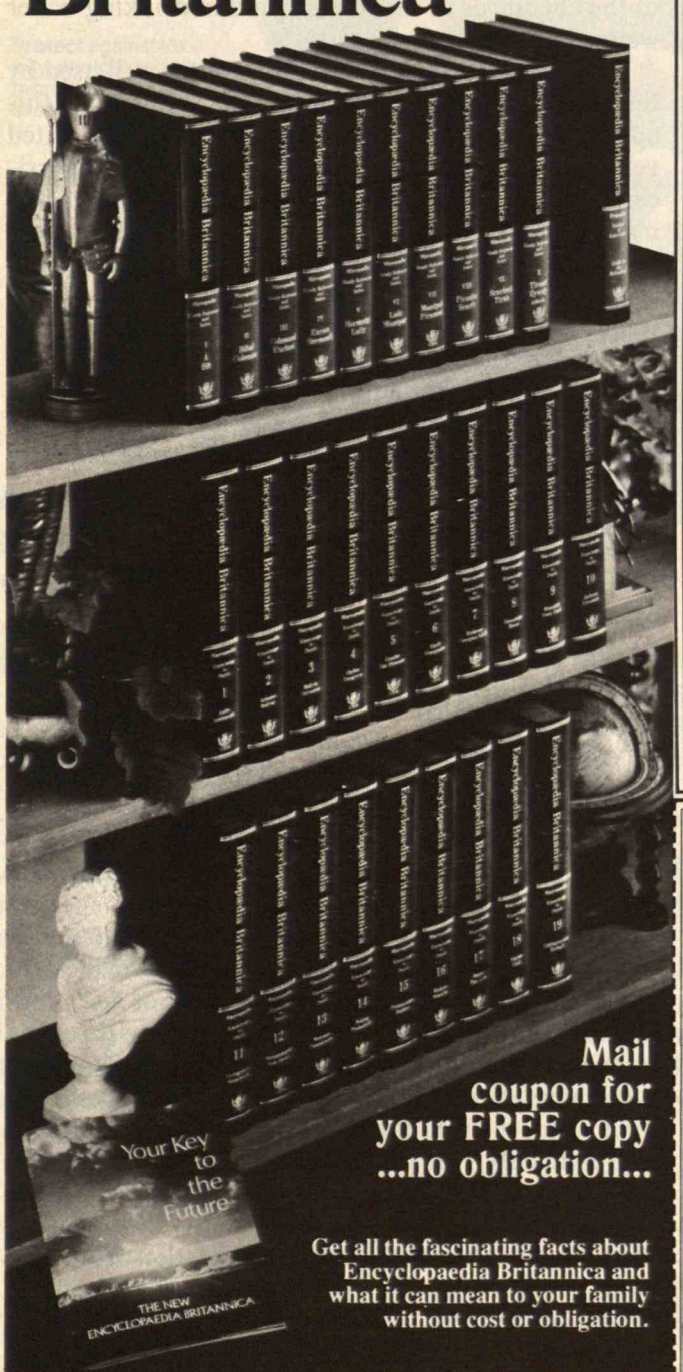
All of the 33 contaminants most commonly found in groundwater are toxic at sufficiently high doses. At least 21 of the contaminants have been the subject of occupational studies, and workers exposed to high concentrations suffer a variety of problems. Many of the compounds depress the central nervous system, causing dizziness, nausea, fatigue, poor coordination, mental dullness, and blurred vision. Several cause liver or kidney damage, and unconsciousness and death have been reported. Studies of occupational exposures suggest that some compounds can adversely affect human reproduction, including dibromochloropropane (DBCP, a pesticide now banned), vinyl chloride, ethylene dibromide, benzene, toluene, and xylene. Infertility, sterility, chromosomal damage, increased incidence of spontaneous abortions, and prolonged menstrual bleeding have been reported.

Until recently, high exposures to these compounds have rarely been associated with drinking water. And especially regarding potential reproductive problems, there is no direct evidence that concentrations found in even the most contaminated groundwater pose a significant health hazard. However, where exposures from consumption of contaminated groundwater have been high, reported symptoms have been similar to

A substantial Group Discount for Technology Review subscribers

You and your family are invited to preview the revolutionary Home Learning Center

The New Encyclopaedia Britannica



Mail coupon for your FREE copy ...no obligation...

Get all the fascinating facts about Encyclopaedia Britannica and what it can mean to your family without cost or obligation.

Available now direct from the publisher at important Group Discount Savings!

Convenient budget terms available!

Britannica 3 is more than an encyclopaedia; it's the first truly unique approach to learning in over 200 years.

The New Encyclopaedia Britannica has been rewritten, reorganized and expanded to an impressive 30-volume library—a complete Home Learning Center in itself.

Not only is Britannica 3 easier to use than ever before—suitable even for younger students—it also brings you more up-to-date facts about more subjects than you'll find in any other encyclopaedia. Just as important, Britannica 3 gives you the depth and detail so important for advanced work; it's the one encyclopaedia that can serve your family from grade school through college and beyond!

What's more, it's packed with *practical* information you'll use in your daily business and personal lives. It covers virtually everything from Art to Literature to Sports, History, Geography, the Sciences and much, much more.

Because Britannica 3 is such a revolutionary approach to learning, we've prepared a full-color booklet that explains its many advantages in detail. The booklet is yours *free,* with *no obligation*. Send for your copy today!

Mail this coupon for your FREE PREVIEW BOOKLET!

GROUP DISCOUNT CERTIFICATE

MAIL TO: TECHNOLOGY REVIEW
Room 10-140
Mass. Institute of Technology
Cambridge, MA 02139

I'd like to learn more about The New Encyclopaedia Britannica, FREE and without obligation. So please mail me the full-color Britannica 3 booklet. I would also like your local sales representative to contact me on how I can obtain Britannica 3 on extremely convenient terms, and, at the same time, receive my FREE PREVIEW. If I decide to purchase Britannica 3 direct from the publisher, I will receive substantial savings extended to my group. Naturally, I'm under no obligation to buy a thing. At this point, I'm "just looking." Thank you.

Name_____
PLEASE PRINT

Street Address_____

City_____ State_____ Zip_____

Signature_____
(valid only with full signature) SOC TP

LITHO IN U.S.A.

Once contaminated, groundwater may remain so for hundreds or thousands of years, if not for geologic time.

those associated with occupational exposures.

At lower concentrations, synthetic organic chemicals are known to produce skin eruptions and impair the central nervous system. And at still lower doses over many months or years—chronic exposure—there are a variety of health problems. One particularly important concern is cancer, which often has a long latency between exposure and manifestation of disease.

Much of the initial work on the cancer risks of drinking water focused on populations consuming chlorinated surface water. Chlorinated surface water usually contains varying amounts of four chemicals of a class called trihalomethanes—chloroform, bromoform, bromodichloromethane, and dibromochloromethane. These and many other halogenated compounds form when chlorine reacts with naturally occurring organic compounds, believed to be mainly humic acids, present in most surface waters. Several recent epidemiological studies have associated chlorinated water with increased cancer risks, especially lower gastrointestinal and urinary tract cancers.

However, there are some important caveats when it comes to correlating the cancer risk of drinking chlorinated water with the risk of drinking contaminated groundwater. Although a few of the compounds are present in both chlorinated surface water and contaminated groundwater, most are different. But the studies do suggest that the cancer risk from contaminants (especially the chlorinated hydrocarbons) found in groundwater—typically at much higher concentrations than in chlorinated water—may be as large as or larger than the risk from the halogenated chemicals in chlorinated water.

Although epidemiological studies do not permit quantitative estimates of the human cancer risks from contaminated groundwater, there is another way to assess risks. (Animal carcinogenicity experiments permit crude estimates of human risk for some of the contaminants.) However, there is considerable debate over the validity of this method, so these calculations should be interpreted carefully.

Fourteen of the chemicals found in drinking-water wells have been tested in animals by the National Cancer Institute (*see the figure on page 58*). The data for 1,1,1-trichloroethane are negative, and the data for 1,1-dichloroethane and parathion are only suggestive. But the remaining 11 chemicals did prove carcinogenic in at least one animal species. Also, two other chemicals—benzene and vinyl chloride—have been established as human carcinogens in several studies.

To estimate the overall risk from consuming these chemicals in drinking water, the first step is to calculate low-dose risks from animal data using a "multistage" method adopted by the EPA. The animal risk data are then extrapolated to humans based on the relative surface areas of the animals and humans. Finally, these data are used to estimate the lifetime risks (at a 95 percent confidence level) from exposure to the chemicals at the levels found in drinking-water wells.

The case of the private drinking-water well used by the family in South Brunswick, N.J., illustrates this approach. (This well is one of the most contaminated yet discovered and is presented in the spirit of "worst-case" analysis.) Researchers have enough data to estimate how much the presence of five chemicals will increase an individual's likelihood of contracting cancer above and beyond the ordinary lifetime risk. We can use estimates by Science Research Systems, Inc. to calculate the risks:

- ☐ TCE (at 1530 ppb) would cause an extra 4.6 cases of cancer in 10,000 people.
- ☐ Trichloroethane (965 ppb) would cause an extra 15.4 cases in the same number of people.
- ☐ Chloroform (420 ppb) would cause an extra 17.2 cases.
- ☐ Carbon tetrachloride (400 ppb) would cause an extra 7.6 cases.
- ☐ Benzene (230 ppb) would cause an extra 10.1 cases.

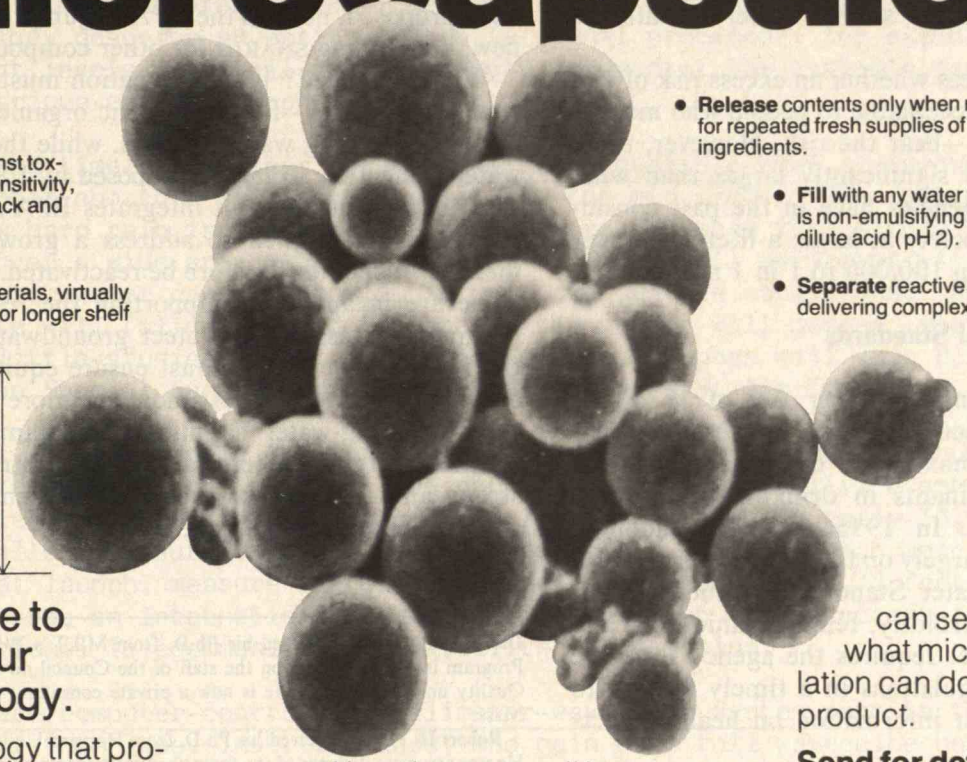
If we assume that the cancer risks are simply additive, in a population of 1 million drinking this water for a lifetime, approximately 5,490 additional people would contract cancer. Or stated another way, an individual drinking this water would face an incremental risk of about 1 in 200 of contracting cancer from this source alone.

Nassau County on Long Island, known to suffer widespread groundwater contamination, provides another illustration. Using concentrations of four contaminants to construct a hypothetical "worst case," an estimated 750 people from a population of 1 million would develop cancer by consuming water from these wells over their lifetime. This represents a risk of approximately 1 in 1,300 for each individual.

Of course, there are many uncertainties in these risk estimates. They include the validity of the multistage model, the method of extrapolation from animals to humans, the possible synergistic effects among carcinogens in the water and with other carcinogens to which humans are exposed, and the possible

How many ways can you use a microcapsule?

- **Protect** against toxicity, photosensitivity, microbial attack and evaporation.
- **Contain** materials, virtually unchanged, for longer shelf life.
- **Release** contents only when needed for repeated fresh supplies of ingredients.
- **Fill** with any water immiscible oil that is non-emulsifying and insoluble in dilute acid (pH 2).
- **Separate** reactive components for delivering complex formulations.



3M Brand microcapsules magnified 800 X

We'd like to share our technology.

A technology that produces microcapsules, 15 to 400 microns in diameter, that act as tiny packages to contain, carry, and preserve your ingredient.

Microcapsules have been used as delivery systems, pressure release capsules, indicators, micro ball bearings — the number of possible applications is virtually unlimited.

Already many well known companies have had products microencapsulated — the result: greater product marketing and sales success.

Free sample microencapsulation of your product.

To show you how microencapsulation works, we will trial-microencapsulate your product free and send it back so you can see for yourself what microencapsulation can do for your product.

Send for details.

This four-color brochure gives you an inside look at microencapsulation; how it works and how to discover what it can do. Write to: Microproducts, Imaging Systems Division, 3M Center, St. Paul, MN 55144.

3M Hears You . . .

3M

To reduce groundwater contamination, the country needs a strong and coherent partnership between the states and the federal government.

presence of carcinogens not yet identified in the water (either because no tests have been conducted or the chemicals were not detected by the analytical procedures used). But it should also be noted that evidence suggests that the results derived from the National Cancer Institute's animal studies underestimate the true cancer risks.

It is difficult to assess whether an excess risk of 1 in 200 or 1 in 1,300 is acceptable to people who must—usually involuntarily—bear the risk. However, these involuntary risks are significantly larger than what many government agencies have in the past considered acceptable to society at large: a lifetime cancer risk ranging from 1 in 100,000 to 1 in 1 million.

The Lack of National Standards

Under the Safe Drinking Water Act of 1974, the Environmental Protection Agency can establish national standards—maximum contaminant levels (MCLs)—for contaminants in drinking water from community supplies. In 1975, the EPA adopted interim MCLs based largely on the 1962 Public Health Service Drinking Water Standards, including standards for bacteria, turbidity, ten inorganic ions, and six pesticides. The act requires the agency to revise and expand these regulations in a timely fashion to account for the latest information on health effects and risks.

The interim standards have not yet been revised as required, but they have been selectively enlarged. In 1976, EPA promulgated standards for radioactivity, and in 1979 promulgated an MCL of 100 parts per billion for total trihalomethanes in community water systems supplying more than 10,000 people. Monitoring of trihalomethanes began in November 1980 for water systems serving more than 75,000 people.

The EPA has not yet proposed MCLs for most synthetic organic compounds found in groundwater. However, some states have adopted temporary "actionable" standards—concentrations at which wells can be closed—for a few compounds. For some of the chemicals, the EPA Office of Drinking Water has prepared nonbinding interim guidelines, "suggested no adverse response level" (SNARL) documents, for use by states and municipalities on a case-by-case advisory basis. Each SNARL is based on a model calculation of human health risks extrapolated from laboratory animal data for acute, subacute, and chronic exposures.

The EPA had planned to propose new MCLs for trichloroethylene, 1,1,1-trichloroetnane, tetrachloroethylene, carbon tetrachloride, 1,2-dichloroethylene, vinyl chloride, benzene, methylene chloride, dichloroethylene, and possibly other toxic organic compounds in early 1981. But these MCLs have not yet been proposed, nor has the EPA begun preparation of new, nonbinding SNARLs for other compounds.

What is needed? First, the nation must have legal standards—MCLs—for many toxic organic chemicals found in drinking water. Second, while the "groundwater protection strategy" proposed by EPA in 1980 was not without flaws, it integrates EPA's programs and policies designed to address a growing health menace. It should therefore be reactivated. The states alone are incapable of supporting the research and programs necessary to protect groundwater quality; the federal government must ensure equity and efficiency in this endeavor. As more and more people lose their drinking-water supplies to contamination by synthetic organic chemicals, the country needs a strong and coherent partnership between the states and the federal government.

David E. Burmaster received his Ph.D. from M.I.T.'s Water Resources Program in 1978 and was on the staff of the Council on Environmental Quality until May 1981. He is now a private consultant in Cambridge, Mass.

Robert H. Harris received his Ph.D. from Harvard University in 1971. He was associate director of the toxic chemicals program for the Environmental Defense Fund from 1973 to 1979, and President Carter appointed him one of three members of the Council on Environmental Quality in 1979. He is currently codirector of the hazardous-waste program at Princeton University's Center for Energy and Environmental Studies and a principal of Environ Corp.

This article is based in part on the CEQ report entitled "Contamination of Ground Water by Toxic Organic Chemicals" published in January 1981.

Further Reading

Crump, Kenny S., and Harry A. Guess, *Drinking Water and Cancer: Review of Recent Findings and Assessment of Risks*. Prepared for the Council on Environmental Quality by Science Research Systems, Inc. Springfield, Va.: National Technical Information Service, 1980.

Freeze, R. Allan, and John A. Cherry, *Groundwater*.Englewood Cliffs, N.J.: Prentice-Hall, 1979.

Kim, Nancy, K., and Daniel W. Stone, *Organic Chemicals and Drinking Water*. Albany: New York State Department of Health, 1980.

Massachusetts Special Legislative Commission on Water Supply, "Chemical Contamination." Boston 1979.

National Research Council, *Drinking Water and Health*, vol. 3. Washington, D.C.: National Academy Press, 1980.

Lewis, Richard J., Sr., and Roger L. Tatkan, eds., *Registry of Toxic Effects of Chemical Substances*, 2 vols. Washington, D.C.: U.S. Government Printing Office, 1980.

Tripp, James T.B., and Adam B. Jaffee, "Preventing Groundwater Pollution: Toward a Coordinated Strategy to Protect Critical Recharge Zones." *Harvard Environmental Law Review* 3:3 (1979).

SCIENCE/SCOPE

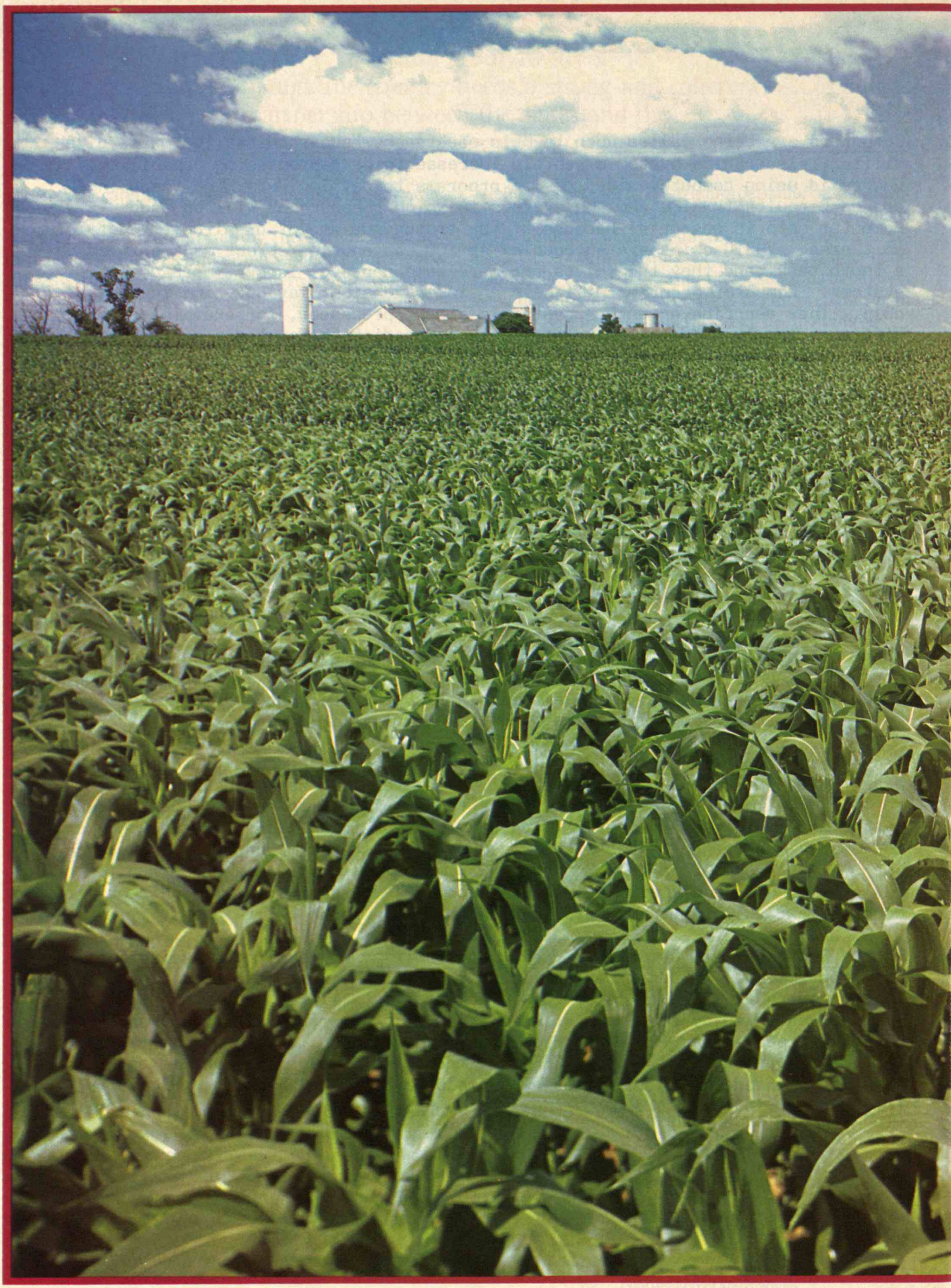
Computers are being called upon to help create the "super chips" that will give military electronics system a tenfold increase in data processing capability. Hughes is using computer-aided design programs to develop Very High Speed Integrated Circuits (VHSIC) and the systems in which these chips will be used. Computer help is essential because of the tremendous amount of circuitry per unit area. VHSIC chips are as complex as 100 Los Angeles street maps printed on a thumb tack, and they themselves are mere components of larger, more complex systems. Computer programs will help engineers design, lay out, and test a chip. They describe an entire system (a signal processor, for example) at many different levels of detail simultaneously to predict the system's performance under various operating conditions.

Better and timelier weather forecasts will be possible when a microwave sensor is launched aboard a military satellite in the mid-1980s. The instrument will tell how hard rain is falling in a specific area rather than simply how much has fallen over a wide area within 24 hours. It also will determine wind speed, atmospheric water content, soil moisture, and sea ice conditions. Because the satellite will follow a low polar orbit, the sensor will gather important data on the little-studied polar regions and oceans. Hughes will soon deliver the prototype Special Sensor Microwave/Imager to the U.S. Air Force.

Intelsat VI will become the world's most sophisticated commercial communications satellite upon launch in 1986. The drum-shaped, spin-stabilized satellite will have twice the capacity of Intelsat V. It will be able to carry 33,000 telephone calls and four TV channels simultaneously. It will weigh more than 8200 pounds at launch, measure 12 feet in diameter, and deploy to 39 feet in height. Hughes heads an international team building Intelsat VI spacecraft for the International Telecommunications Satellite Organization.

A complete computer-controlled millimeter-wave test system permits the user to measure return loss, insertion loss, and gain over full waveguide bandwidths up to 110 GHz with a 0-to-25 dB measurement range. The solid-state Hughes 4788xH system has an optional automatic frequency control that allows the frequency of the test generator to be set with an accuracy of plus or minus 0.01 percent. The analyzer consists of the Hughes 4772xH millimeter-wave sweep generator, a Hewlett-Packard HP-85 computer, a full-band reflectometer with 40 dB directivity couplers and calibrated standard, and an analyzer with a built-in display.

Hughes Radar Systems Group has career opportunities for engineers, scientists, and programmers. We design and build many of today's most complex airborne and spaceborne radar electronics systems, including data links, electronic warfare systems, and display systems. We need scientific programmers, systems analysts, microwave specialists (antenna, receivers, transmitters, data processors), circuit designers (analog, digital, RF/IF), mechanical designers, systems and test engineers. Send resume to Engineering Employment, Dept. SE, Hughes Radar Systems Group, P.O. Box 92426, Los Angeles, CA 90009. Equal opportunity employer.



PHOTOGRAPHS: GRANT HEILMAN

Below:
Plant root system showing nitrogen-fixing nodules.

The farmer's most farfetched fantasy—growing crops that require no fertilizer—may well become a reality. But deciding on an effective strategy to achieve this end is a major challenge of basic science.

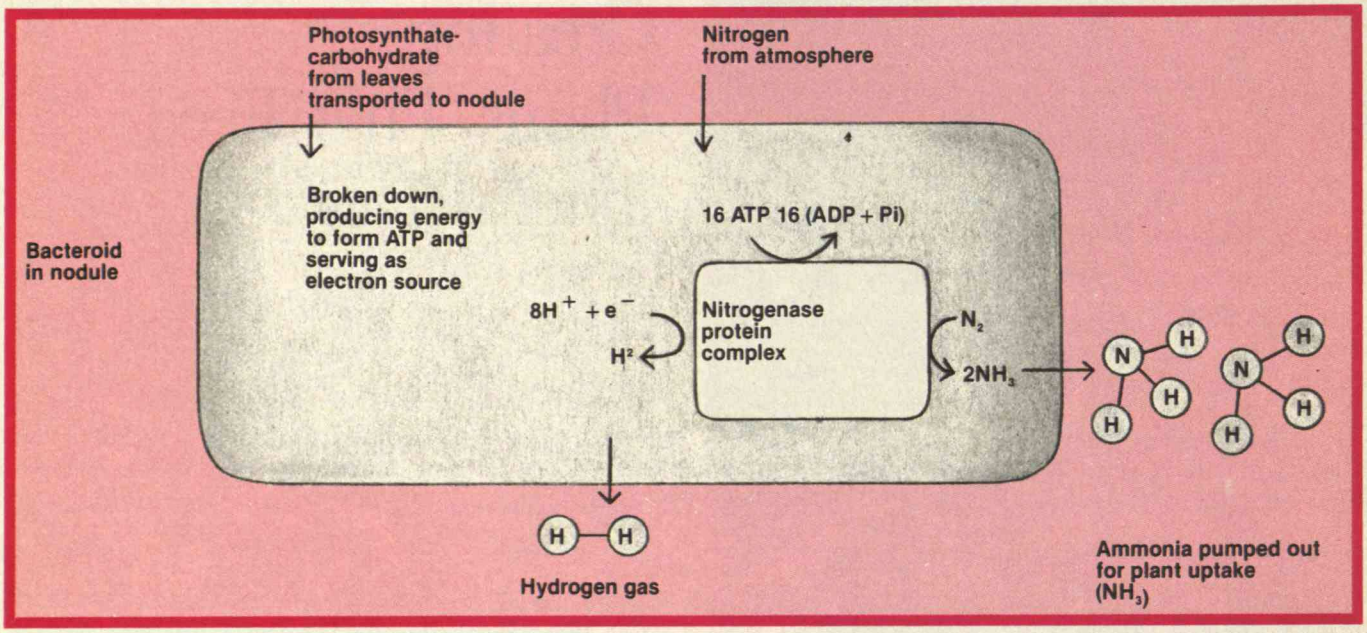
Creating Plants That Feed Themselves

by Christopher D. Earl and Frederick M. Ausubel

OVER the past decade, the cost of nitrogen fertilizers has placed an exponentially increasing burden on farmers. This price spiral is largely due to the demands of fertilizer manufacturers for huge amounts of natural gas. An acute problem for American agriculture, the price of fertilizer is an even greater obstacle to expanding food production in many less developed countries. These countries face a growing threat of widespread famine.

Both economic and humanitarian urgency, then, is spurring researchers in a variety of fields to explore ways of improving the energy efficiency of nitrogen fertilizer manufacture, or of reducing agricultural demand for synthetic nitrogen. Biologists are currently bringing to the latter effort several unique approaches, most of which arise from a novel and powerful synthesis of recombinant DNA technology with advances in cell genetics and classical plant breeding. Many of these researchers are especially concerned with creating varieties of the major cereal crops—corn, wheat, and rice—that are more self-sufficient in acquiring necessary nitrogen compounds. In the next few years, development of both technology and basic understanding will determine the nature of any biological solution.

Schematic diagram of the chemical processes that occur during nitrogen fixation in legume nodules. Nitrogen from the air is converted into ammonia with energy derived from photosynthesis.



DAN COLLINS

A necessary element in the composition of proteins, nucleic acids, and other major cellular components, nitrogen is an essential molecular building block for the growth of all organisms. But it is one of nature's great ironies that most life forms, including all plants and animals, are unable to enlist dinitrogen gas (N_2), which comprises 80 percent of the atmosphere, in their life-sustaining biochemical processes. Plants are able to use nitrogen in the form of nitrate (NO_3) or ammonia (NH_3), but these compounds are present in limited supply in the soil and are easily lost by both leaching and biological reduction of NO_3 to N_2. Because crop plants generally require relatively large amounts of nitrogen for growth, nitrogen frequently becomes the limiting soil nutrient for plant growth. Hence, plants must constantly extend their roots in the search for more nitrate and ammonia, while their leaves are bathed in a sea of nitrogen gas.

Given the numerous routes by which nitrogen is removed from the environment, how does nature balance the nitrogen budget? The majority of organic, or "fixed," nitrogen is produced by a highly specialized class of bacteria and blue-green algae that have evolved complex systems for the enzymatic reduction of nitrogen to ammonia. These soil microbes—called "nitrogen fixers"—are invisible but ubiquitous. They come in two varieties: free-living nitrogen fixers that generate NH_3 for their own use, and symbiotic nitrogen fixers that usually inhabit special nodules formed on plant roots, there exchanging surplus ammonia for food and a protected habitat. Microorganisms provide the bulk of fixed nitrogen in the ecosystem; of the estimated 255 million tons of N_2 fixed annually worldwide, 69 percent, or 175 million tons, comes from biological nitrogen fixation. Even in cultivated soils, these microorganisms generate twice as much fixed nitrogen as farmers apply in fertilizer.

The Fixers

The symbiotic partnership between the bacterial genus *Rhizobium* and leguminous plants is particularly important in agriculture. *Rhizobium* is present in most soils in a free-living but nonfixing phase and will infect the roots of germinating legumes. Each species of legume—soybeans, peas, clover, alfalfa, and so on—can form a symbiosis only with a particular strain of *Rhizobium*. Once inside the root, an intri-

The biggest payoff would come from the tallest order: the genetic engineering of plants that fix nitrogen themselves.

cate relationship develops. The plant surrounds the rapidly reproducing bacteria with a spherical or cylindrical "nodule" of root tissue, and the bacteria invade the individual root cells, there differentiating into the state in which they can fix nitrogen. At this stage, they are called bacteroids. Each nodule, packed with bacteroids, is a tiny ammonia factory fueled by photosynthate—the carbohydrate produced in the leaves by photosynthesis and passed down through the stems to the roots.

Hence, legumes can thrive in nitrogen-depleted soils and will even enrich the earth with surplus organic nitrogen. We are all familiar with crop rotation, the ancient practice of alternating cultivation of nitrogen-hungry grains with legumes such as alfalfa. The legumes can be plowed under to further enhance soil fertility. Although application of nitrogen fertilizers has largely taken the place of crop rotation in modern agriculture, both methods have their drawbacks. Crop rotation takes up much of a field's productive cycle in growing legumes, and nitrogen fertilizers are expensive and can pollute water supplies.

We are still looking for better ways to cope with the fact that the world's major cereal crops, as well as the grasses that serve as primary forage crops, do not form nitrogen-fixing symbioses. Worse, the high-yielding varieties of corn, wheat, and rice bred during the Green Revolution were selected, in part, to give high yields in response to generous applications of nitrogen fertilizer. In the 1950s, fossil fuels and nitrogen fertilizer made from them were cheap; few worried that to fuel such high-yielding varieties, farmers would have to apply nitrogen fertilizer in amounts far greater than required by wild strains.

The Root of the Problem

Approaches to providing important food crops with a steady nitrogen supply vary widely, ranging from tinkering with existing systems to creating entirely new kinds of plants. For example, it is possible to enhance fixation within existing symbioses. Indeed, in the controlled environment of the lab, enhancement of fixation has already been accomplished with soybeans and *Rhizobium*. Improved strains of symbiotic as well as free-living bacteria might be selected. More ambitious proposals include creating new symbioses between bacteria and cereals or grasses, developing, for example, corn plants that form nodules as pea plants do. Of course, the biggest payoff would come from the tallest order: the genetic engineering of cereals that fix nitrogen themselves. Here, genes for the structural and enzymatic components of nitrogen fixation would be "built into" the plant's DNA, making it independent of fertilizers and bacteria.

To evaluate each of these strategies, we must understand the unique biochemical properties of microbial nitrogen fixation. The system has been most successfully studied in the free-living bacterium *Klebsiella pneumoniae*. *Klebsiella* is a close relative of *Escherichia coli*, common resident of the human gut and the foot soldier of genetic research; their kinship has facilitated the exploration of nitrogen-fixation genetics.

Investigators have found a single cluster of 17 genes that carry the code for all the enzymes that participate in nitrogen fixation. At the heart of this complex system is the remarkable enzyme called nitrogenase. This enzyme mediates one of the most energy-expensive reactions known to occur in living cells. Though more efficient, molecule for molecule, than the energy-expensive industrial manufacture of fertilizer, a great deal of biochemical energy goes into breaking the triple bond of a nitrogen molecule and the reaction of each nitrogen atom with three electrons and three hydrogen ions. Each reduction of an N atom to NH_3 may require as many as seven molecules of adenosine triphosphate (ATP, the central unit of energy exchange in living cells). By comparison, in photosynthesis, the incorporation of a carbon atom from CO_2 into a glucose molecule requires only three ATP molecules. This is why biological nitrogen fixation is most often associated with the energy-producing reactions of photosynthesis, whether in legumes or photosynthetic bacteria and blue-green algae.

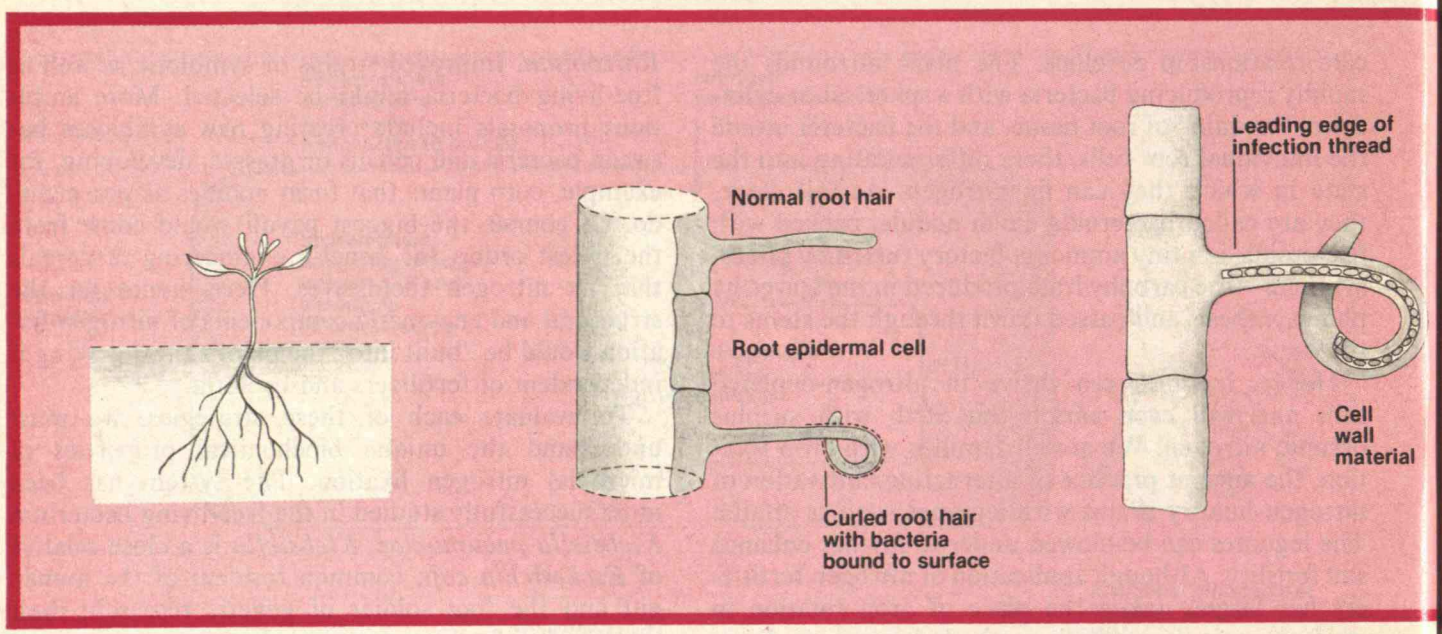
One other important feature of nitrogenase, often encountered as a nasty technical complication by those who study nitrogen fixation, is its extreme sen-

Stages in the development of nitrogen-fixing nodules.

Roots of germinating, uninfected plant encounter and perhaps attract Rhizobia living independently in the soil.

Specific recognition between legume and appropriate species of Rhizobium takes place; bacteria bind to the root hairs and induce curling.

In a small proportion of the root hairs, the bacteria invade the cell and begin to multiply. The plant contains and directs them by laying down cell-wall material around them, thereby forming an "infection thread."



DAN COLLINS

sitivity to oxygen. All nitrogen-fixing microbes have evolved strategies for protecting their nitrogen-fixation systems from oxygen, which inactivates nitrogenase. *Klebsiella*, for example, fixes nitrogen only in oxygen-poor environments. *Rhizobium* synthesizes the necessary enzymes only in root nodules, where the bacteroids are bathed in a plant protein called leghemoglobin, which essentially serves as a filter for regulating the O_2 flux to the bacteroids. As we will see, oxygen sensitivity remains a major problem in the development of new nitrogen-fixing organisms.

Making a Good Thing Better

The next few years may well bring modest improvements in nitrogen-fixing biotechnology. By developing improved strains of plants and bacteria, scientists may make the *Rhizobium*-legume partnership more efficient. Variant strains of *Rhizobium* that are better nitrogen fixers than their wild ancestors have already been created through genetic selection. In pure lab cultures, the soybeans grown with these new strains are more robust and productive. In the field, however, lab strains are poorly matched against their natural competitors. It has been impossible so far to effectively colonize fields with improved *Rhizobium* strains. New strains must now be equipped to compete in the extremely complex and little-understood microenvironments of the soil.

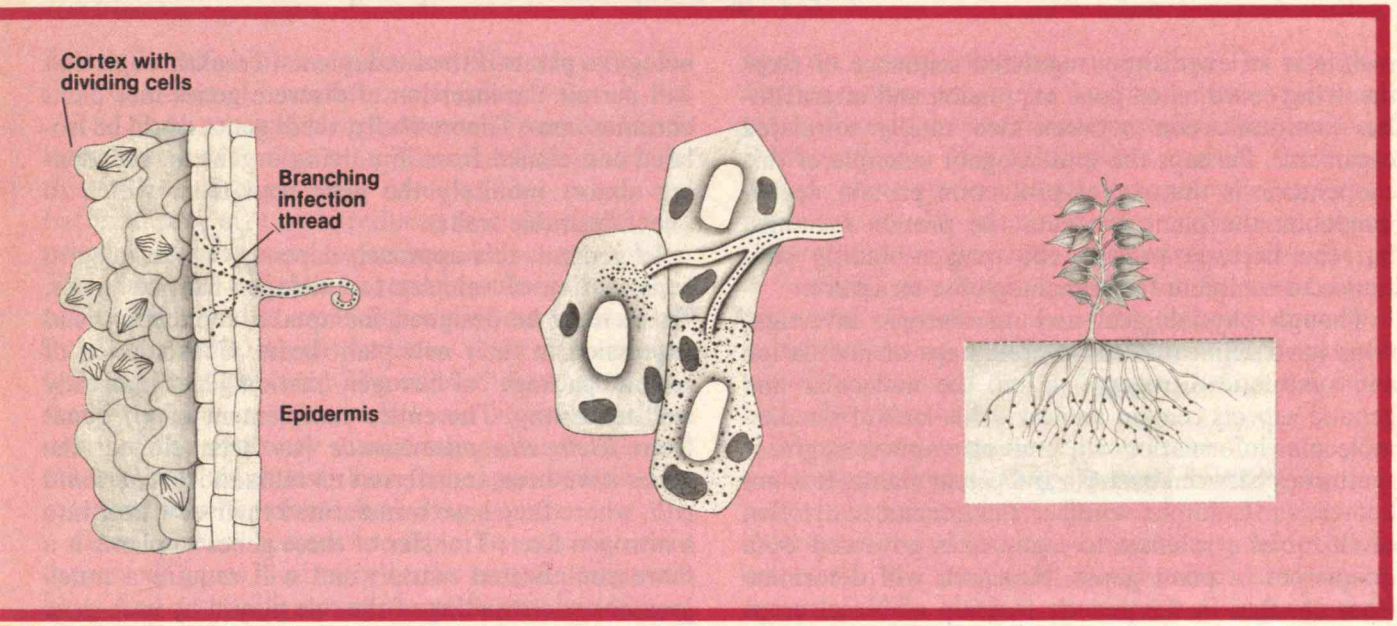
If this important obstacle can be hurdled, other varieties of super-*Rhizobium* may be developed. For example, the nitrogen-fixing capacity of nitrogenase is handicapped by its ability to react with hydrogen ions as well as nitrogen: it catalyzes the formation of hydrogen gas from hydrogen ions found in water. In fact, the root nodules of soybeans have been shown to waste up to 55 percent of the energy potentially available for nitrogen fixation in the formation of hydrogen gas. Some *Rhizobia* have avoided this problem with an enzyme called hydrogenase that captures the H_2 by-product and recycles it back into the production of NH_3. But not all *Rhizobia* have good hydrogenase systems, and it may be possible to engineer them for greater efficiency.

On the plant side of the relationship, some improvements may be made in the uptake of fixed nitrogen from the root nodules. Apparently about 35 percent of all soybean varieties are "leaky"—they lose

The infection thread branches and penetrates many cells. Cells in the root cortex grow toward the infection thread, thereby forming a nodule.

When the infection thread penetrates these dividing cells, the bacteria are released into the cytoplasm of the cells. The bacteria then develop into nitrogen-fixing bacteroids, and the plant cells produce leghmoglobin, which shields the bacteria from oxygen.

Nitrogen-fixing plant with nodules



much of the ammonia from bacteroids. Obviously, it is desirable to breed this "leakiness" out of the affected soybeans. In addition, research aimed at improving plant photosynthesis may provide a side benefit in boosting nitrogen fixation. Soybeans will dramatically step up their rate of photosynthesis in an enriched CO_2 atmosphere. Reacting to the increased photosynthate, the bacteria in the root nodules can fix substantially more nitrogen, while the plant can build more nodules.

Super Cereals

Valuable as it may be to augment existing symbioses, these efforts will have little bearing on the larger goal of forging an association between the major cereal crops and biological nitrogen fixation. There are three major proposals, all long-term projects, for bringing nitrogen fixation to cereals. First is the use of certain naturally occurring associations between nitrogen-fixing soil bacteria and the roots of cereal plants to enable the bacteria to contribute a significant portion of the plants' nitrogen requirement. Second is the genetic manipulation of cereals and *Rhizobium* to permit them to establish a symbiotic relationship. Third is the use of recombinant DNA techniques to transfer the entire nitrogen-fixation apparatus from bacteria to plants.

Development of associative symbioses has received a great deal of publicity recently, probably in excess of its potential importance. The casual nature of associative interrelationships is their greatest disadvantage. Both plant and microbe can do fine without the other, and it may be difficult to design a way to direct export of sugars to the bacteria and ammonia back to the plant. Unless the associative bacteria have an almost exclusive relationship with the host plant, the exported sugar will be available to any other soil microbes in the neighborhood. These might even outcompete and displace the nitrogen-fixing bacteria. The same would be true of the ammonia produced by the bacteria—little of it would be likely to reach the plant.

More promising but also more daunting is the idea of increasing the "host range" of *Rhizobium* to include cereals. Problems arise from the extraordinary complexity of the interaction between the plant host and bacterium. The development of the legume

Until recently, plant breeding was the sole method for crop improvement.

nodule is an exquisitely regulated sequence of steps involving coordinated gene expression and intercellular communication between two totally unrelated organisms. Perhaps the most elegant example of this cooperation is the oxygen-protection protein, leghemoglobin: the plant produces the protein subunits, but the bacteria provide the oxygen-binding substance to complete the leghemoglobin structure.

Though physiological and microscopic investigations have delineated the overall steps of nodulation and symbiotic nitrogen fixation, the molecular and genetic aspects remain unclear. This lack of detailed molecular information will limit attempts to engineer symbioses between bacteria and cereal plants. It is not known, for example, whether the general restriction of rhizobial symbioses to legumes is governed by a unique set of plant genes. Research will determine what changes in the genetic makeup of cereal crops are needed to permit the symbiosis to develop.

But why go to all the trouble of coaxing interspecies harmony? Why not just engineer the important agricultural crops to fix nitrogen themselves? Rapid leaps in our understanding of the genetics of nitrogen fixation have turned this old fantasy into a tantalizing possibility. Obviously, such a scheme would avoid the problems inherent in the manipulation of two organisms at once. Coaxing bacterial nitrogen-fixation or *nif* genes to express themselves in plants, and getting the enzymes to function in so foreign an environment as a plant cell, certainly complicate the problem. Especially knotty are the questions of energy supply and oxygen sensitivity of nitrogenase. Nonetheless, the idea deserves careful exploration.

Making Waves in the Gene Pool

The widespread application of recombinant DNA technology allows scientists to consider the feasibility of such gene transfer. Until recently, conventional plant breeding was the sole method for crop improvement, and it is still preeminant. But scientists can cross only closely related species and varieties—those that naturally, or with some encouragement, will breed with each other. The application of recombinant DNA technology to plants is the fundamental breakthrough that will permit the insertion of discrete genes into plant chromosomes. Theoretically, these genes could be isolated and cloned from any living organism, broadening almost infinitely the gene pool from which to select desirable traits.

In general, this approach depends on the in vitro construction of vehicles for nitrogen-fixation genes. These must be designed for uptake, replication, and expression in their new plant hosts. Construction of such a "package" of nitrogen-fixation genes is already well underway. The entire complement of *nif* genes from *Klebsiella pneumoniae* has been cloned; the genes have been transferred en masse to *Escherichia coli*, where they have transformed their new host into a nitrogen fixer. Transfer of these genes to plants is a more complicated matter, and will require a much greater understanding of the role played by each gene product in the overall process. We also must know how these genes are "turned on" to begin directing the synthesis of nitrogen-fixation enzymes, and to what extent they are expressed relative to one another. Studies of these questions are proceeding, and we now have the technology with which to complete the analysis in a reasonably short time.

The "package" will include a number of additions to the bacterial genes. First, the "vector," or DNA into which the genes are cloned, will have to be compatible with plants and suitable for uptake by plant cells in culture. Second, the package must be able to integrate into the plant genome without disrupting normal cell function. Third, pieces of plant DNA that will permit proper expression of the nitrogen-fixation genes will have to be spliced in among the *nif* genes.

A number of recent discoveries are laying the foundation for potential gene-transfer systems. For example, the bacteria that cause crown gall disease are known to transfer some of their genes to plant cells (*see "Engineering a New Agriculture" by Robert Cooke, May/June, page 22*). Much has been learned about the structure and function of DNA from plant viruses and organelles that could ultimately lead to the construction of vectors for gene transfer. Plant genes themselves are being studied intensively to

Rapid leaps in our understanding of genetics have turned an old fantasy into a tantalizing possibility.

determine which DNA sequences will be important for the expression of bacterial DNA in plant cells.

The plant, too, will have to be made receptive to the introduction of foreign DNA. The most likely route for this will be through plant tissue culture, where the bacterial DNA may be introduced into plant cells, and proper integration and expression can be selected for. The plant cells will then be regenerated into full-sized adults. Pilot studies are being carried out on the family *Solanaceae*, which includes tobacco, petunias, tomatoes, and potatoes. The cells of these plants are readily grown in culture. We can already perform many of the necessary manipulations in petunia and tobacco cells; doubtless these techniques will soon be extended to other plants, including cereals.

Once it has become possible to establish and express *nif* genes in plant cells, the next challenge will be to find a suitable environment, both physical and biochemical, for the nitrogen-fixation process. Recall the three main requirements for nitrogenase function: a large supply of energy in the form of ATP, a large supply of electrons, and oxygen-poor conditions. Addition of nitrogen-fixation ability might unduly burden the energy supplies of the plant cell, drawing ATP and electrons from other essential processes. Were this the case, a nitrogen-fixing plant might be too inhibited in its growth to be of agricultural value.

In fact, this may not turn out to be a problem at all, since nitrogen fixation would take the place of the plant's natural nitrate uptake system. This system uses almost as much ATP and just as many electrons as nitrogen fixation in obtaining nitrate from the soil and converting it into ammonia. With sufficient fixed nitrogen supplies, the plant might be able to greatly augment the growth of its photosynthetic structures, which would in turn provide the energy needed by the nitrogen-fixation system.

The oxygen sensitivity of nitrogenase is a much thornier problem, not likely to be approached until earlier stages of this project are completed. It is difficult to find an oxygen-poor region of the plant cell and the engineering of nitrogenase genes into plants could founder at this point. Though it will be some time before we will be ready to tackle the problem head on, several solutions are possible. The nitrogen-fixation system might be localized within plant-cell chloroplasts, the specialized organelles that carry out photosynthesis. The chloroplasts contain their own genetic blueprint in a small DNA molecule, and their genes are similar in many ways to bacterial genes. Chloroplasts also generate ATP, converting the energy of sunlight into chemical energy for cell metabolism. Since the chloroplasts are where nitrate is converted to ammonia, they could be expected to cope with the ammonia produced by nitrogenase—which might be toxic elsewhere in the cell.

The problem with chloroplasts is that they also generate oxygen during photosynthesis, creating the danger of inactivating nitrogenase. Nonetheless, the chloroplasts contain cytochromes, special proteins involved in the generation of ATP, which are oxygen-sensitive. Thus, there is some hope of finding a partially oxygen-free environment within the chloroplasts.

In the last stage of the project, any grains or grasses engineered to fix nitrogen will have to be bred with appropriate agricultural varieties so that they will grow and produce well wherever they are needed. Here decades of experience with plant breeding will be put to the test in the development of hybrid strains compatible with endogenous nitrogen fixation.

Each of these strategies for broadening the biological share of agricultural nitrogen input has its virtues and pitfalls. Clearly, we must learn a great deal more about the molecular biology of symbiosis, the ecology of the soil, and the biochemistry of both nitrogen fixation and plant gene expression to determine which strategies will most likely succeed.

As industrial production of nitrogen fertilizer consumes vast amounts of natural gas and the price of new fertilizer plants approaches $150 million, alternatives must be developed that do not use up costly nonrenewable resources. Since atmospheric nitrogen and sunlight are virtually limitless and free resources, the argument for making plants self-sufficient in nitrogen production is a compelling one.

Christopher Earl is a graduate student in the Division of Cellular and Developmental Biology at Harvard University. Harvard professor **Frederick Ausubel** is a leading researcher in molecular genetics. □

Offshore Arctic oil
Until Exxon learned

Dr. Anton Prodanovic is designing Arctic drilling islands that open a new world of energy.

Conventional offshore oil-drilling techniques simply won't work in Alaska's Beaufort Sea. Forces generated by Arctic ice could endanger the most rugged platforms now being built. But, America needs the Beaufort's oil. And Dr. Anton Prodanovic, Senior Research Specialist of Exxon Production Research Company, is helping us reach it. Dr. Prodanovic and a team of Exxon civil engineers are designing man-made islands which allow us to drill safely in the ice-covered waters of the Beaufort.

Developing an I.Q. for ice

Key to determining the design of these islands (establishing such criteria as slope angles, freeboard elevations and berm heights) is getting to know the ice that will surround them. Since 1968 Exxon has pioneered in learning how Arctic ice grows, moves and behaves, and the forces it can exert.

Much of Exxon's Arctic ice research actually happens at −25°F in, of all places, Houston, Texas. Here, Dr. Prodanovic and other "island" engineers work closely with Exxon "ice" scientists. By studying, analyzing and testing core samples of ice flown down from the Beaufort Sea, a specific island design can be planned, taking into account a multitude of sea ice factors: sea ice structure (is it granular, columnar, or leached?); sea ice strength (compressive, tensile, shear or flexural); sea ice loads, pressure and movement in winter and summer; and whether the ice is multiyear or annual.

Island design and construction

Once the ice environment, oceanographic and geotechnical aspects of a particular site have been studied, Dr. Prodanovic and his team can begin the design for a new island Drilling operations require a working surface of more than two acres on a circular-shaped island. This surface

was unreachable. how to break the ice.

lso provides sufficient space for a rest-raising berm and a buffer zone ehind the berm to accommodate otential ice-override pileups.

Island construction can be ccomplished during the winter. Trucks arry gravel to the island site over an 8-ot-thick ice road constructed on top of he sea ice. The fill must be carefully laced and gradually built up from the ea floor to a safe freeboard elevation. he slope angle of gravel island eaches is 1:3, shallow enough to inimize fill erosion and give the island design resistance greater than otential ice forces.

Island safety and defense

For a few brief weeks each summer, he ice along the Beaufort coastline elts. To prevent slope erosion and rotect the island from wave attack, a ayer of hydraulic filter cloth is used to stop fill washout and the buildup of hydrostatic pressure in the underlying fill. On top of this, a cover layer of sandbags holds the filter cloth in place and further minimizes erosion.

While the island's mass is its first defense against winter ice attack, a secondary defense is ice slotting or trenching. An earth-trenching machine is used to cut a circumferential slot approximately 8 inches wide in the ice sheet. This defensive slot weakens the ice so that it collapses before ice loads become too large.

In addition to these defensive measures, monitoring stations and pressure sensors placed near the island provide continuous surveillance of ice movement and behavior.

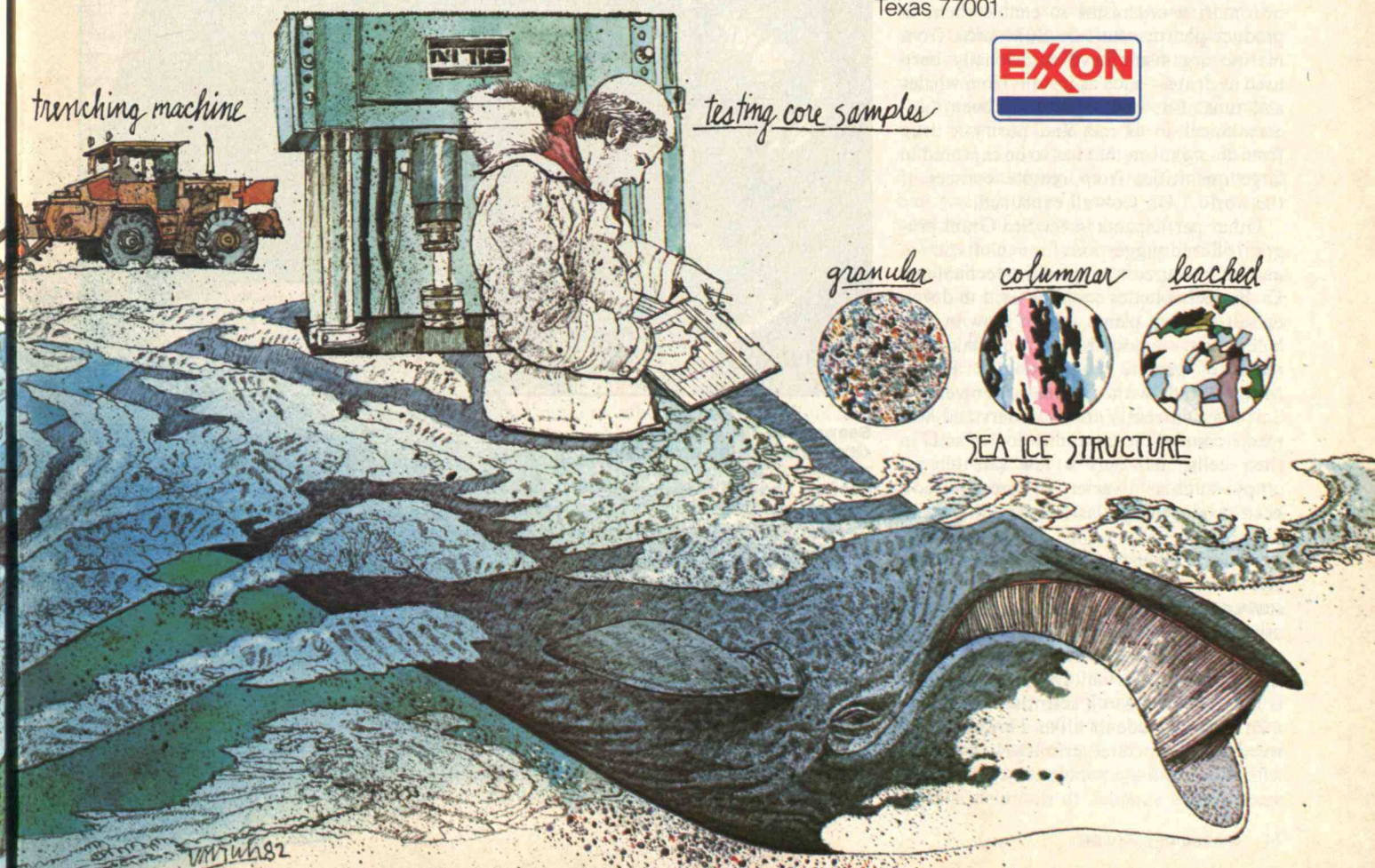
Over the past 4 winters, Exxon has built and drilled on 3 islands in the shallow, close-to-shore areas of the Alaskan Beaufort Sea. They have proven to be an efficient, effective way to tap energy that was once unreachable.

Exxon Production Research Company

Offshore drilling systems and ice research are just two of the activities at EPRCo. A wholly owned subsidiary of Exxon Corporation, the company employs over 1000 scientists and engineers working in the fields of petroleum exploration and production, aimed at finding, producing and improving the recovery of worldwide energy sources.

If you would like more information about Dr. Prodanovic's work and EPRCo, write J. A. Rickard, Exxon Production Research Company, Room 607, P.O. Box 2189, Houston, Texas 77001.

EXXON



TRENDS

High Tech for the High Seas

Even before Columbus dispelled the myth that the oceans lead directly to the underworld, the seas were valued for their resources as well as their trade routes. But a new chapter may be starting: biotechnologies may bring unprecedented harvests from the seas—new organisms, pharmaceuticals, and tools to increase the productivity of those exploiting the oceans.

There is a "staggering potential for genetic engineering of [marine] species," according to microbiologist Rita Colwell, director of the Sea Grant Program at the University of Maryland. At an M.I.T. Sea Grant lecture this spring, she offered some predictions: Microorganisms will be genetically tailored to biograde pollutants such as oil, and to attack marine organisms such as barnacles that cause troublesome "biofouling" of ships and other submerged structures. She also predicted that genes that synthesize drugs will be transplanted into marine organisms to enable them to produce pharmaceuticals. Substances from marine organisms have occasionally been used as drugs—such as insulin from whales and tuna. But it has generally been "uneconomical to extract and purify a drug from an organism that has to be captured in large quanitities from remote corners of the world," Dr. Colwell explained.

Other participants in the Sea Grant program offered suggestions for exploitation of marine resources by genetic technology:

☐ Biotechnologies could be used to develop salt-tolerant plants able to grow in salt-laden soils, suggested John Vournakis, director of genetic engineering at Bristol Meyers and with Syracuse University. Scientists currently do not understand how plants control the concentration of salts in their cells, and only a few salt-tolerant crops—such as a variety of tomato—have been produced by classical breeding techniques.

☐ Donald Cheney, biologist at Northeastern University, described new prospects for seaweeds. Seaweed extracts are already used as thickeners and stabilizers in many prepared foods, and to make agar, the gelatinous medium for culturing bacteria, that is familiar to research scientists and freshman biology students alike. However, seaweed is still harvested primitively by divers with rakes, and the population cycle of seaweed causes supplies to diminish sharply

Seaweed by the beaker. *Gracilaria* is being genetically modified to provide agar, a bacteria and cell growth medium widely used in research but always in short supply. Donald Chaney of Northeastern University hopes to use cell fusion techniques (*Gracilaria* protoplasts shown in insert) to develop a hybrid seaweed strain that grows fast and yields high-quality agar. It could then be grown commercially in large ponds; now, agar-producing seaweed is inefficiently harvested by divers using rakes.

every 15 years. Dr. Cheney hopes to use the techniques of cell fusion and tissue culture to produce a hybrid seaweed strain that not only can grow fast and in tanks, but also can produce high-quality agar. He predicted that this could become an important industry, and added that "there may be other uses for agar that haven't even been pursued yet because of the low supply." (*See "New Genes for Old Beans," February/March, page 75.*)

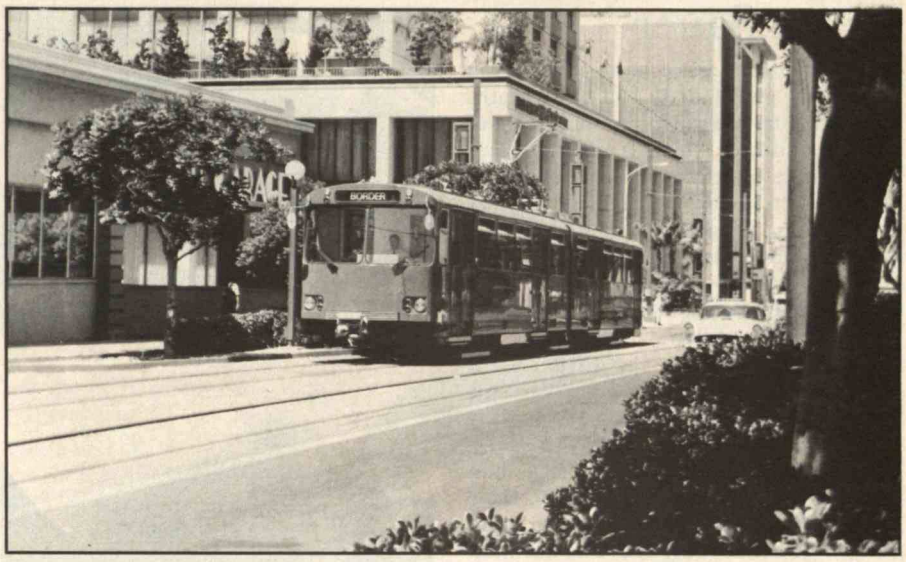
☐ Genetic technologies may provide hardier stocks—or entirely new organisms—to be farmed from the sea. Recalling the case of modern corn, which was bred from spindly, grasslike ancestors, John Ryther of the University of Florida suggested that genetic engineering could improve fish and marine invertebrates for faster growth, higher quality, and better survival.

☐ Given such developments, Scott Sindelar of DeKalb AgResearch, Inc., waxed enthusiastic about aquaculture as a future source of human food. Fish require less feed per pound of food value than beef. Original costs—the animal plus its food and care—represent 55 percent of the price of beef but only 35 percent of the cost of fish. The remainder stems from marketing, distribution, transportation, and other factors, costs that will drop as production increases. And if faster-growing fish can be developed, the cost of fish in comparison to beef will improve even more.

But Dr. Sindelar acknowledged some problems. The aquaculture industry is highly fragmented, restricted to certain areas, and has little capital to invest in research and development. Furthermore, George Whitesides of M.I.T. said that profitable aquaculture demands a controlled environment with considerable engineering requirements: water quality control, storm protection, pest control, and specialized feeding and harvesting equipment. In contrast to Dr. Ryther, he warns that genetically engineered species might be more fragile than native organisms, requiring extra care.

In fact, Professor Whiteside added, the basic tools for marine biotechnology—such as cloning "vectors" to transfer DNA in gene splicing—still need to be developed. But before they are, we should question whether genetic engineering can bring overall economic improvement with new products—be they drugs, crops, or seafood—or simply replace today's products with new ones. He suspects that in some cases the best opportunities for productive research may be in far less exotic technological change.—*Barbara Goldoftas* ☐

For a mile the new San Diego trolley runs in city streets; then it shares a 15-mile track with freight trains to the Mexican border. It's successful, say its planners, because it's simple: modern veneer on the technology of 75 years ago, when 45,000 miles of electric street railways served 11.3 billion U.S. passengers a year. (Photo: San Diego MTDB)



Keeping It Simple in San Diego

To riders of BART and METRO, the San Diego Trolley may look more like a toy than the real thing. But San Diegans take their trolley seriously, and so did hundreds of public-transport specialists who came to pay homage at two meetings on urban mass transit early this spring.

The San Diego Metropolitan Transit Development Board's 16-mile trolley line between the city center and the Mexican border is a bright spot in the generally lackluster record of U.S. urban transit. The trolley line officially opened on July 18, nearly on schedule and exactly on budget. Its daily passenger load is already well above forecasts, and 83 percent of its operating costs have been covered by what has come out of the fare box.

There seem to be two reasons for this $86 million success story:

☐ In an era when most innovators are caught up in high technology, the San Diego Trolley is explicitly low technology. "Keep it simple" was the basic idea of everyone, says Dennis Wahl of the Metropolitan Transit Development Board.

☐ San Diego has a spacious city center and enjoys one of the country's truly equable climates. Under these conditions, it's simpler to be simple.

Because the city is roomy, the tracks could be laid on downtown streets for ten blocks in the city center. The builders simply scraped off 18 inches of pavement and soil, renewed a few utilities, and put down tracks on a new ballast foundation. For its high-speed, off-street segment, the trolley shares a right-of-way originally built for Southern Pacific freight trains. All the rail—but only 40 percent of the ties (the city's very dry weather preserves them)—were replaced. Even some of the 27 grade crossings were retained without rebuilding.

Cars for the trolley are from the German firm Siemans/DuWag. The only unconventional thing about them is the absence of air-conditioning (it's almost never hot in San Diego). Power comes from the simplest kind of overhead line.

Stations for the San Diego Trolley are minimal: they are simply open shelters from the sun (that pleasant climate, again) with computerized ticket vending machines. Roving fare collectors exact heavy penalties from passengers without tickets—the fare evasion rate is just over 1 percent, according to Mr. Wahl.

The cost for all this—including acquiring and refurbishing track, 14 trolleys, and all the accessories—was $86 million, modest by any standard for a rail transit system on even a shared right-of-way. That funding came wholly from state and local sources with no federal help. Given the success of the original investment, the same sources are being tapped to upgrade the system with double tracks and more cars to improve service. There's also talk of using similar trolleys on other San Diego commuter routes—and hope, no doubt, for the same kind of notoriety once achieved for a choo-choo serving Chattanooga.—*J.M.* ☐

Heart Saver

More Americans die of heart attacks than of anything else. Indeed, half of all deaths in this country are caused by some form of coronary disease, which is usually manifested in the clogging of blood vessels that carry oxygen to the heart, brain, and other vital organs. Clogging is caused by the buildup of atherosclerotic plaque, which is composed mainly of cholesterol and other fats. If left untreated, this buildup can slow or even halt blood flow.

Diet and drugs are the treatment of choice for early signs of coronary disease. But coronary bypass surgery—the grafting of veins to actually bypass vessel obstructions—has been used in an increasing number of cases that do not respond to these less dramatic measures. In fact, over 120,000 patients underwent this debilitating procedure last year, at an average cost of $25,000.

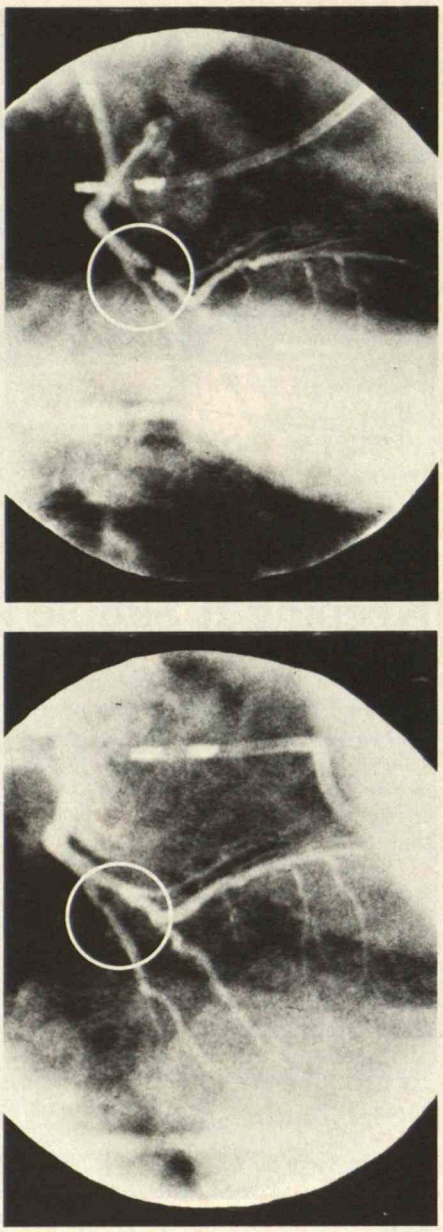
However, there is another, less invasive way to treat coronary vascular disease. Called angioplasty, it is far less complex and costly than bypass surgery. Yet, according to researchers speaking at the 1982 American Association for the Advancement of Science meeting in Washington, D.C., 83 percent of patients who successfully weather the procedure show no symptoms of disease a year after it is performed.

The principle behind angioplasty is uncommonly simple. It entails inserting a thin, flexible catheter into a blood vessel in the groin, through which a still-thinner catheter is threaded into the coronary artery. A tiny, elongated balloon on the small catheter tip is then inflated, applying pressure to the arterial wall. This pressure causes the plaque to fissure, and, if the blood is moving rapidly enough, some of the plaque particles are dissolved or swept away. Pictures of vessels taken before and after successful angioplasty show a marked increase in the diameter of the arterial lumen, the channel through which blood flows.

Angioplasty is also used to unclog arteries that serve the kidneys and limbs. Serious atherosclerosis in these vessels can contribute to hypertension and, in limbs, may force amputation. A recent study at the University of Chicago showed a 73 percent "salvage rate" of angioplasty-treated legs that would have otherwise required amputation.

Introduced in this country in 1977 by Dr. Andreas Gruentzig, who developed it in his native Switzerland, angioplasty is now performed in over 70 centers nationwide. However, physicians are quick to caution that it is applicable to only 12 percent of all heart patients, and it is an alternative to, not a substitute for, bypass surgery.

The left coronary artery of this heart patient is occluded with plaque deposits, which appear as a dark space on this angiogram. During angioplasty, a catheter is threaded into the vessel and its balloonlike tip is inflated to break up and compress the fatty deposits. After angioplasty (below), this patient's vessel is clear.



A status report published in the *New England Journal of Medicine* last year stated that angioplasty successfully dilated the vessels of 63 percent of the 1,500 patients who had undergone the procedure by April 1981. The most common reason for failure was an inability to reach or penetrate the diseased vessel's lumen—a necessary step for effective dilation. Even when this is achieved, side effects ranging from severe chest pains (21 percent of patients) to death (1 percent) were reported. However, patients in this relatively experimental group were at very high risk to begin with—all had failed to respond to medical treatment and were candidates for bypass surgery before opting for angioplasty.

The main drawback of angioplasty is that it can trigger heart attacks. Plaque dislodged by the balloon can get wedged further down the artery and, if blockage is complete, precipitate a coronary arrest. However, the faster the blood is flowing, the less likely it is for a plug to form, so physicians are counseled to administer drugs such as nitroglycerine to speed up blood flow while performing the operation. Also, anticoagulation drugs such as aspirin and dextran are sometimes injected to inhibit clotting.

The ultimate usefulness of coronary angioplasty has yet to be determined. The long-term effects are still unknown, and authorities are reluctant to make predictions. But, at less than one-sixth the cost of bypass surgery and requiring a significantly shorter recuperation time, it is widely hoped that angioplasty will prove a viable, safe, and permanent alternative.—*E.R.S.* □

Dragging Shipping Toward Safety

Nearly three-quarters of 1 percent of the world's ocean-going shipping tonnage is lost every year to accidents—groundings, founderings, collisions, and structural failures. Though shipping technology is constantly improving, that figure for losses has been stubbornly constant for at least 30 years.

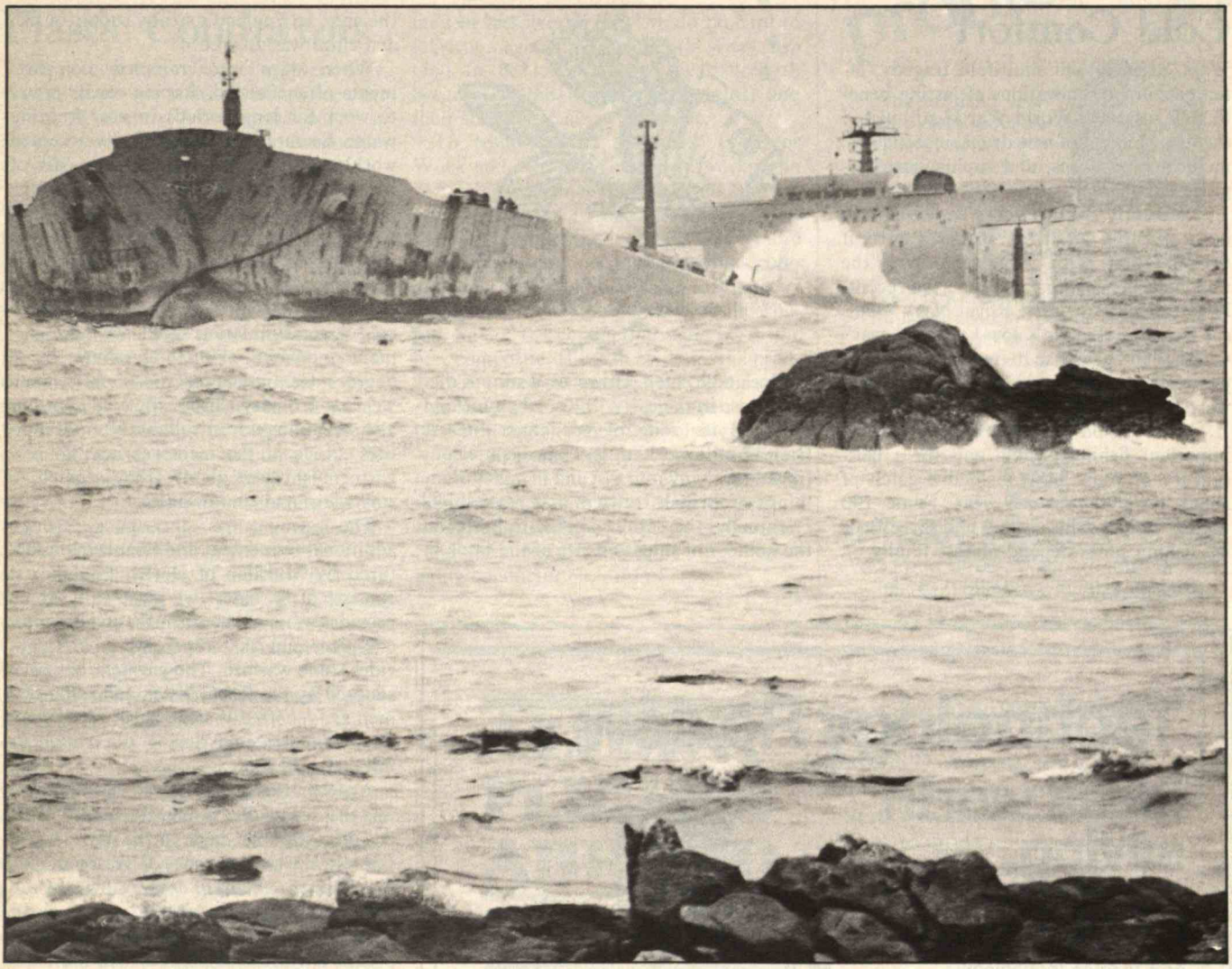
Why?

Because naval architects, shipowners, captains, and rating bureaus have too often failed to embrace important new technologies and heed the lessons that can be drawn from the 300 ships lost at sea every year, says Ernst G. Frankel of M.I.T.

Some examples cited by Professor Frankel at a mid-winter M.I.T. seminar:

□ The *Amoco Cadiz* has two parallel steering motors. She went aground off the north coast of France because the single hydraulic system serving both was ruptured, the critically needed spare part was not aboard, and the captain delayed taking either of the two steps—anchoring or seek-

The *Amoco Cadiz* sinks off France, one of 300 ships lost at sea every year. She ran aground when the hydraulic system serving two parallel steering motors ruptured. Although redundant systems are now required in all new ships, little has been done to document the human errors that turned a mechanical problem into an environmental disaster.



SIPA PRESS, BLACK STAR

ing a tow—that could have saved the ship. The rating bureaus have since required redundant hydraulic as well as steering systems in all new ships. But little has been done to document for other captains the human errors that turned a mechanical problem into an environmental disaster.

☐ Some 60 or 70 bulk carriers for sulfuric acid are now on the high seas. An average of one a year is lost to structural failure because of corrosion. But new ships for this hazardous service are not yet being built of materials impervious to attack by sulfuric acid.

☐ In over 60 percent of recent serious ship casualties, lifeboats proved useless: they simply could not be launched. But most ship classification societies still insist on lifeboats as an essential safety feature while ignoring the new, more launchable inflatable and rocket-borne devices.

But these archaic ways are changing, says Professor Frankel.

Owners and insurors are beginning to see the need for careful studies of how ships were lost and might have been saved—the kind of studies that are now routine following the loss of any commercial aircraft. From such findings will come the first serious opportunity for owners and captains to learn what to do and not to do on the basis of others' successes and failures. A rich harvest of new technology awaits owners, builders, and operators, too. A suitably programmed computer can increase a container ship's capacity by showing how to maximize loads of fuel and deck cargo without raising the ship's center of gravity too high, both when loaded and when half its fuel has been expended on the high seas.

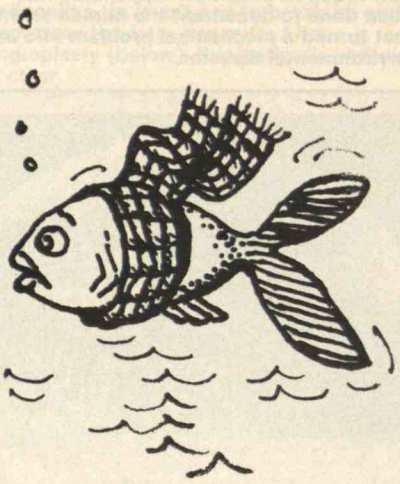
A microcomputer on the bridge can be an invaluable aid to both captain and navigator; programmed with information on the speed of the ship, the speed and shape of its propellers, the condition of the sea, and the speed and direction of the wind, such a computer could predict sea-keeping qualities, aid navigation, and warn of dangers.

Because not all of the complex forces of wind and waves that buffet a ship at sea can be quantified and modeled in a laboratory, most ships are built on the basis of empirical rules with safety factors added. But that's about to change, for new analytical techniques are far more sophisticated. Naval architecture is becoming an exact science, says Professor Frankel, capable of making future ships significantly safer and more efficient than those of today.—*J.M.* ☐

Cold Comfort

Wars, despite their multifold tragedy, often encourage innovations of lasting benefit. For instance, World War II stimulated the development of new drugs, insecticides, medical procedures, and sophisticated logistic techniques.

Apparently the war doesn't even have to be a shooting affair, as Britain's current confrontation with Argentina over the Falklands is becoming. As reported recently by researchers in the Royal Navy Medical Services, Britain's low-key "cod war" with Iceland gave rise to improved personal protection against cold weather and cold water.



MARCI DAVIS

The waters off Iceland are Britain's most important fishing ground and for a half-century or more have yielded a catch of about 170,000 tons per year. Some 190 British vessels fish the area, and three British fishing ports depend almost totally on the Icelandic catch. However, a serious dispute arose in the early 1970s, when Iceland extended its zone of economic interest from 12 miles to 50 miles. The dispute continued for many months, and included rammings of British trawlers and navy ships. Eventually, the nations agreed to limits on the number of ships and size of the catch in the area, so England's steady supply of fish and chips was assured.

When ships were rammed, compartments often flooded, forcing repair crews to work for long periods in near-freezing water. Seafarers have historically accepted working in such environments as part of life at sea, and there has been little change in the ordinary seaman's work clothing.

To provide some protection from the cold for the "cod fleet," British researchers designed a low-cost, waterproof garment of polyurethane-coated nylon. Tested in a cold-water simulation tank, the new garment increased skin temperature by 5 degrees Centigrade or more. Also, men wearing ordinary clothes shivered continually, becoming uncontrollable after 20 minutes. None of the men wearing the new garment shivered at all—they seemed to stay warm and comfortable.

The garment has since gone through additional refinement and is now manufactured by Multifab of Derby, England. It consists of an inner two-piece suit, which provides most of the warmth, and an outer one-piece suit that repels water and provides some warmth. The garment has been adopted by the Royal Navy, and some seamen are reportedly using them for protection from the cold during the Falklands military operation.

Another thermally related development was the design of a standard life raft. Various changes were made in the new 25-person raft, which replaced a 20-person model, to reduce the effects of cold. A low seat was installed to keep occupants off the floor; tests showed that this raised buttock temperature by several degrees. Also, an improved raft canopy provided better dead-air insulation, raising inside temperatures by 5 to 10 degrees.

Disabling cold injuries during war have been common and devastating. Napoleon's 1812 withdrawal from Russia is perhaps most famous, but soldiers have suffered in more recent campaigns as well. During World War II, American forces in Europe had 91,000 casualties from the cold. Only 15 percent returned to full active duty, and hospitalization time averaged 50 days. The U.S. 8th Air Force, operating in Europe in 1943, had more casualties from frostbite than combat.

If we look at the relatively straightforward advances in cold protection prompted by the cod war, it seems that even a small amount of research attention to such problems can have important, and warm, rewards.—*Nicholas A. Bond Jr., Office of Naval Research, London* □

Plastic Conductors

When it comes to conducting electricity, plastics don't—or at least that has been the rule until recently. Now organic polymers show promise of becoming the conductors as well as the insulators of the future.

Some recently developed polymers act as "nonmetal" metals, because they are extremely good conductors. Enthusiasts proclaim them the forerunners of a new class of electronic materials that will reshape tomorrow's high technology.

Just as nylon freed textile designers from the constraints of cotton and wool, so conducting polymers can be engineered on a molecular scale to free electronic designers from the constraints of today's metallic conductors and semiconductors, Alan G. MacDiarmid of the University of Pennsylvania told the American Chemical Society's spring meeting. Indeed, said G.B. Street of IBM's San Jose Research Laboratory, the conductivity of such polymers can be varied virtually at will to suit a designer's needs—all the way from the absence of conductivity typical of an insulator to nearly that of copper wire.

Professor MacDiarmid described a polymer battery in which metallic impurities introduced by "doping" polyacetylene could be withdrawn and then added again to achieve the required charge-discharge cycle. The energy density of such a battery would be about the same as in a conventional lead-acid battery, but the power density would be much higher because polymers are so much lighter than lead. In an electric car, such a battery could be fitted inside the door—an example of the versatility of polymers, said Professor MacDiarmid.

But don't throw away your old battery yet, warned J.R. Ellis of Princeton Polymer Laboratories, Inc. He doubts that batteries will be a major application of conducting polymers in the 1980s—lots of development work remains. But he's optimistic for a "billion-pound" market for polymers to replace metals as electrical conductors by the end of the decade, thanks to the polymers' long list of desirable qualities: variable conductivity, processability, flexibility, low cost, low density, and uniformity. Use of polymers as semiconductors in photovoltaic cells is another interesting possibility.

Though he shares everyone's enthusiasm for the potential of conducting polymers, Professor Gary Wnek of M.I.T. stressed some disadvantages yet to be conquered. Present polymer conductors do not readily melt or dissolve, so they would be hard to fabricate, said Professor Wnek. They also tend to be low in mechanical strength because of the introduced dopants, and their stability in air is very poor.

To resolve these problems, Professor Wnek and Mary E. Galvin are working in M.I.T.'s Department of Materials Science and Engineering to combine such an "intractable" conducting polymer with a more conventional polymer matrix such as polyethylene. The trick is to find a way to keep the conductivity high—that is, to incorporate lots of the conducting material in the new composite. If it can be done, the product will soften on heating, making it easy to process. And it will be permanent, in contrast to today's conducting polymer.

One intriguing possibility was suggested by Professor MacDiarmid: by imbedding the conductor carefully in the matrix, it should be possible to create a polymer that conducts in one direction only—a self-insulating conductor.—*J.M.* □

When Rain Turns Acid

The enigmas of environmental policymaking are nowhere more clearly exposed than in the case of acid rain.

Everyone agrees on the basic proposition: sulfur oxides and nitrogen oxides are emitted from the combustion of coal and oil and from metal-refining plants. They rise into the atmosphere and travel long distances with the prevailing winds, all the while reacting with water vapor to form nitric acid and sulfuric acid, which then fall back to earth in rain or snow. This increases the acidity of land and water, thereby jeopardizing the natural ecology of lakes, forests, and perhaps even farmland.

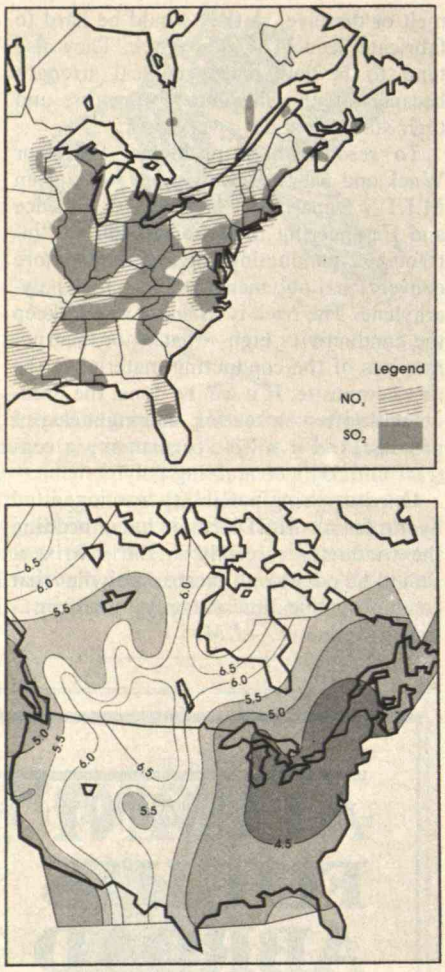
But our understanding of the mechanisms and details is far from perfect. The acid-rain process involves very small amounts of materials in very large environments. Evidence linking specific sources to affected ecosystems is largely circumstantial. Measurements—if they can be made at all—are time-consuming, expensive, and subject to error.

Given these uncertainties, and the current federal emphasis on cost-benefit analyses, regulation of the sources of acid rain seems unlikely. At a five-day symposium on acid rain at the American Chemical Society's spring meeting, Anne M. Gorsuch, administrator of the Environmental Protection Agency, said: "The American people have the right to expect that their government will not impose an additional multi-billion-dollar program without first determining with some degree of assurance that the intended environmental benefits will be achieved. We must begin to ask how clean is clean."

As researchers presented more than 75 technical papers on acid rain at the ACS meeting, questions outnumbered assertions. Some highlights:

The efficiency with which cloud droplets absorb acidifying pollutants depends on the turbulence of the rainmaking system, and that is hard to measure and harder to predict. Furthermore, sulfur oxides and nitrogen oxides can sometimes be neutralized in the atmosphere.

Scientists at Argonne National Laboratory reported that during one air-sampling flight in May 1981, aerosol upwind of Chicago was more acidic than downwind, the opposite of what would be expected. Also, calculations by William D. Bischoff and associates at Northwestern University reported that as little as 25 percent of the acidifying pollutants released over the eastern United States show up in acid rain; the fate of the remaining sulfur and nitrogen oxides is "enigmatic."



Circumstantial evidence, obvious in these maps, links sulfur dioxide and nitrous oxides emissions (top) with downwind acid precipitation (bottom). Normal rain has a pH of 5.0 to 5.5; lakes whose pH has fallen to 4.0 and lower show reduced diversity of life. Do prevailing winds carry the midwest's pollutants into the east's watersheds? (Charts: Ontario Ministry of the Environment)

Some of the acid in rainfall is rendered harmless after it reaches the ground. Harold F. Hemond of M.I.T. reported "strong evidence" that in some New England lakes and reservoirs, biological processes operating during the warmer months neutralize the nitric acids; a lesser portion of the sulfuric acid also may be neutralized naturally. Professor Hemond does not say this means acid rain isn't a problem, and he is not yet ready to speculate on the mechanisms involved. However, he does think that "the situation is more complex than commonly believed, and in need of more study."

P.L. Brezonik and his colleagues at the University of Minnesota, who are also studying such "buffering" effects, find that shallow lakes increase in acidity more slowly than deep ones—but they may also retain their acidity longer if the input of acid is decreased.

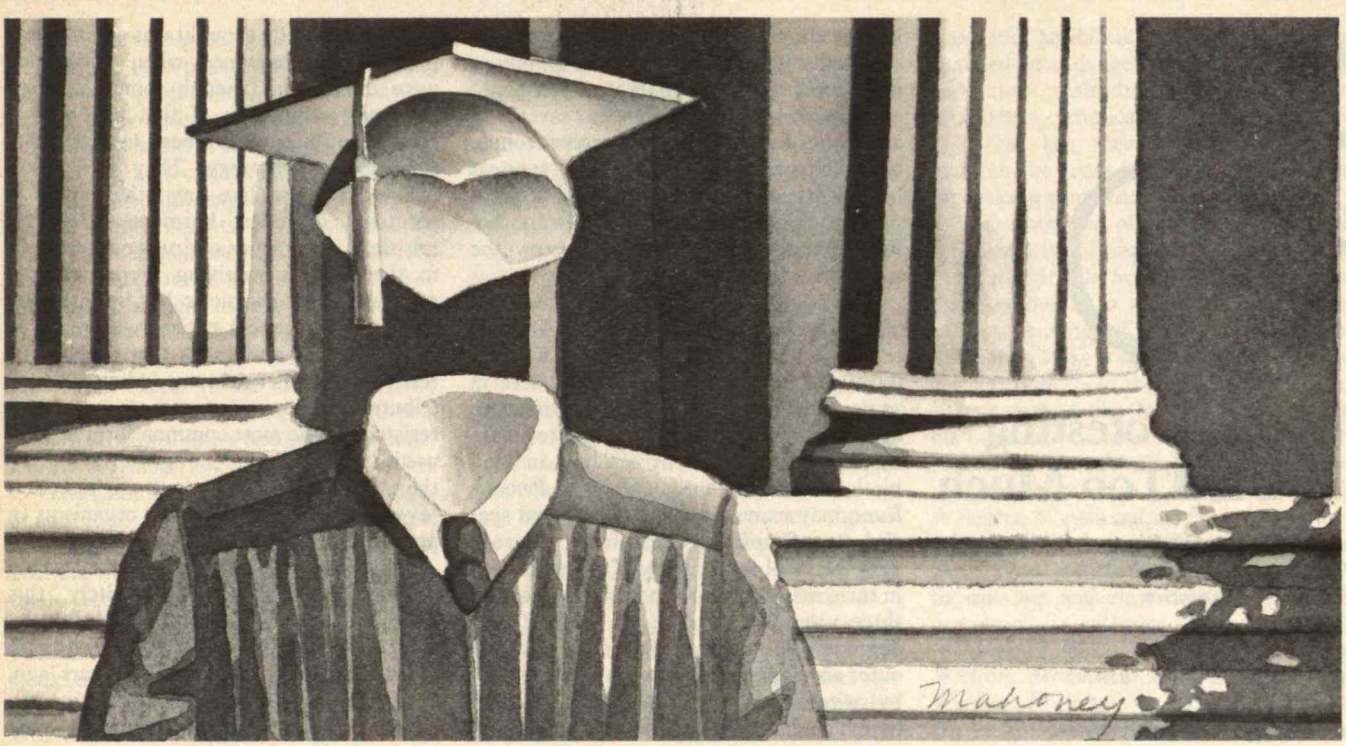
Fish are the most obvious victims of acidified ecosystems, but that is not a simple matter either. When K.H. Mills of Winnipeg's Freshwater Institute deliberately decreased the pH of a small Manitoba lake, three of the five fish species present—including lake trout—flourished, while two species decreased dramatically. Further acidification changed the balance again by causing reproductive failures in the trout.

Studies at the Ontario Department of Fisheries and Oceans show that adult fish of most species tolerate acidity well enough; it is usually the fingerlings that die. Perhaps this is because acid precipitation increases the mobility of aluminum in an ecosystem, and young fish and plants tend to be intolerant of aluminum.

Laboratory research suggests that acid rain may affect forests by making trees more susceptible to insect infestation or microbial disease, perhaps even stimulating growth of the pest organisms, said William H. Smith of Yale's School of Forestry and Environmental Studies. But there is as yet "no evidence from studies of large trees under field conditions," he emphasized.

On the other hand, tests at the University of California's Department of Plant and Soil Biology showed that the productivity of barley and clover increased in slightly acid soil. Acid rain contributed nitrogen and sulfur and released calcium and potassium from the soil. These were then taken up by the plants as nutrients.

Given these uncertainties, how are we to weigh the cost of reducing acid rain against the benefits of doing so? An example of the difficulty was provided by Professors F.C. Menz and J.K. Mullen of Clarkson College of Technology, reporting their study of the Adirondack sport-fishing industry. Acidification has destroyed about 4 percent of the fishable acreage—perhaps 100 ponds in northeastern New York state. But there still seems to be room for all the anglers on the rest of the Adirondack ponds. Indeed, it is hard to prove any real economic losses to the region. And Ms. Gorsuch's demand for "some degree of assurance" is obviously hard to fulfill.—*J.M.* □



KATHERINE MAHONEY

Democracy in Academia

"You, sir, are a charlatan and a fraud," charged a student to a recent guest lecturer at M.I.T. "And you are stifling my creativity." A faculty member at the well-attended seminar, after "enduring an hour of hearing my beloved Institute berated," left in a tense and emotional flurry. Such responses might have inhibited or at least embarrassed the average speaker, but this one and his agenda were far from average: Ralph Nader was lecturing students—and he clearly had students, not teachers, researchers, or other scholars in mind—on "The Social Responsibility of the University."

Nader not only endured the criticism, he encouraged it. "It's good that you say such things; they show that some juices are flowing. [And the essence of civil liberty] is to defend the rights of people who disagree with you." He similarly explained his "berating": "I'm talking about preponderences. Given the steady influences of corporations at M.I.T., please forgive me if I devote my one brief hour here to stressing the 'parochial' interests that aren't often represented."

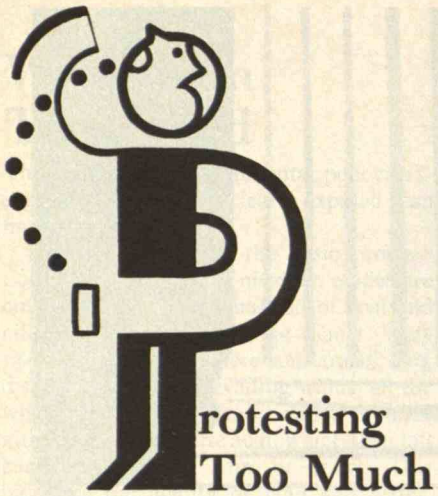
His primary concern is that universities are becoming the "vanguard of mercantilism"—subsidiaries, in effect, of large corporations—ever more dependent on corporate resources as public funds dwindle. This tendency may well improve industrial innovation, productivity, competitiveness, and profits. But it is a "road to perdition," Nader said, because other values such as the health of future generations, consumer safety, and civil rights will receive less and less attention. These values are simply not part of a corporation's "shielded mission," nor is it obliged to defend them. A university's purpose, on the other hand, is "to create a diversity and be accessible, to act as a 'sensitive membrane' whose nourishment comes from throughout the spectrum of the democratic society."

Mr. Nader cited as an example his early failure to find a single automotive-safety researcher at M.I.T. when he was a student at Harvard Law School (pursuing a project that was later developed in his book *Unsafe at Any Speed* and his well-known adversary relationship with the auto industry). He also offered as an example the national failure to properly manage the "defecations of the nuclear industry." Such omissions, he claims, are not necessarily conspiratorial; they occur simply for lack of economic demand in the private sector. The stimulus that drives the private sector thus unduly influences the research priorities of universities and the young people they educate.

"Engineering has put itself on the side of wasteful technologies," Nader maintained, because education has become "vocational." It produces "tradespeople" who simply do their jobs, ask no questions, and take home their pay, instead of "professionals" who address problems first and their own roles in them second. "A first-rate engineer without a philosophy," he said, "is a robot."

Students may be comfortable with academic matters, Nader observed, but they are exceedingly *un*comfortable as citizens. They generally fail to acquire the interests and skills of citizenship during their college training. As a result, they find their "lucrative niche" and "walk about in invisible chains" throughout their careers.

Nader said that he is not counseling doctrinaire advocacy—he is not assuming that companies or schools of management are "evil." He *is* counseling the individual to address the "moral content" of his or her choices. Quoting Alfred North Whitehead—"duty arises from potential control over the course of events"—and recounting opportunities for technologist-graduates of elite institutions, he claims that duty is placed upon these people whether they like it or not. It all comes down, Nader says, to the following question: "How are you going to spend yourself?"—*S.J.M.* □



Protesting Too Much

Germs That Won't Die: Medical Consequences of the Misuse of Antibiotics
Marc Lappe
Garden City, N.Y.: Anchor Press/Doubleday, 1982, 246 pp., $14.95

Reviewed by William Bennett

From time to time, as I enter the subway I pass a young man who stands addressing inattentive pedestrians on matters of social and political importance. Bullhorn at his lips, this sidewalk orator manages to make even opinions I agree with sound repellent or vacuous.

In his new book, Marc Lappé achieves a similar effect. The author's purpose is altogether noble: to warn his readers, presumably a general audience, that antibiotics are being so misused and overused as to pose a risk to public health. But his book is so loosely argued and carelessly written that I not only lost patience with its point of view but was tempted to dismiss, as hysterical, some worries that are certainly valid.

When antibiotics first came into widespread use just over three decades ago, they were almost immediately heralded as "wonder drugs." Easier to say than the unfamiliar term "antibiotic," "wonder drug" also seemed a perfectly appropriate description of agents that broke dangerous fevers and dispelled life-threatening infections, sometimes within hours. Today the expression sounds embarassingly naive.

The change in terminology does not merely reflect our habituation to the miraculous. Antibiotics today are in fact less wonderful than they were in the 1950s, even though they have been steadily "improved" by their manufacturers. The reason is well understood: microbial evolution is exceedingly efficient, and resistance to antibiotics is emerging almost as rapidly as new forms go on the market. This should come as no surprise—microbes "invented" antibiotics for their own purposes a couple of billion years ago, and these organisms had plenty of practice in finding ways to parry each other's biochemical thrusts before human beings began to borrow the weapons.

An antibiotic is a compound released by a microbe into its surroundings. Antibiotics do not harm the organism that produces and releases them, but interfere in some specific way with the vital processes of other microbes that attempt to share their resources. Thus by exuding an antibiotic, a mold, such as a species of *Penicillium*, may manage to keep a bacterial species, say *Staphylococcus*, from overrunning the local food supply. The bacterium, in turn, may disarm the antibiotic in one of three ways: by secreting an enzyme that degrades the antibiotic, by redesigning its outer envelope to exclude the substance, or by switching off the vulnerable portion of its metabolic machinery and relying on an alternative set of enzymes not affected by the antibiotic.

This sort of chemical arms race uses a lot of energy. When organisms can avoid engaging in it, they evidently do. But given any period of exposure to a particular antibiotic, a population of bacteria is almost certain to acquire resistance—often very rapidly.

The secret of bacteria's success lies in the library of formulas they maintain as antidotes to antibiotics. The genetic code for these resistance factors is often carried outside the main chromosome in a detachable bit of DNA called a plasmid. Plasmids may be lost, gained, or exchanged with other bacteria, and resistance factors can be transferred in this fashion not only between individuals of the same species but sometimes from one bacterial species to another. Thus, resistance can emerge rapidly in a population that seems altogether sensitive to an antibiotic.

And that is precisely what has happened since the late 1940s. Certain groups of bacteria have become sturdily resistant to agents that once obliterated them. Some examples include types of bacteria living in hospitals or on the skin of hospital personnel, certain venereal-disease bacteria (especially those causing gonorrhea), and the fecal bacteria of livestock fattened on grain laced with antibiotics. In addition, many disease-causing microbes now respond only to much heavier doses of antibiotics.

Relatively little thought was given to the prospect of resistance when antibiotics were introduced (though some scientists were perfectly aware of that possibility). Hence, antibiotics have been used without an ecological strategy. They have been licensed for use like any other drugs—sedatives, diuretics, hormones. But the misuse of other kinds of drugs matters only to the patients receiving them, whereas each use of an antibiotic has implications for every subsequent patient who requires it. Any use of antibiotics that encourages resistance to emerge in one individual contributes to the emergence of worldwide resistance. The most common form of misuse is undertreatment: not giving enough of the antibiotic to wipe out an infection leaves only the most resistant organisms to prosper and spread.

If it were possible to go on discovering useful new antibiotics indefinitely, this state of affairs might be acceptable. But the last fundamentally novel type of antibiotic (rifampicin) was identified 15 years ago, and we cannot expect scientists to unearth new ones at a sufficiently rapid rate to keep us ahead of our bacterial opponents.

To keep existing antibiotics effective, we need a master plan for deploying them. We could restrict the use of certain agents for a period of years, say, to allow resistance to decline, or specify dosages and schedules of administration so that even partially resistant organisms are killed. Certain types of use might be prohibited altogether. For example, antibiotics that are useful in human beings might be prohibited for use in animals. Perhaps antibiotics should not be added to animal feed, as they currently are, to offset the deleterious effects of crowding in feedlots and pens. (Fully half of the antibiotics currently produced in the United States are used for this purpose.)

It doesn't take an incisive social critic to recognize that efforts to control the use of antibiotics are likely to encounter opposition from some of the stock "bad guys" of American capitalism. Drug companies and agribusinesses stand to lose money. Doctors stand to lose a bit of their cherished freedom to practice individualistic medicine. Antibiotics may also provide a perfect setting in which to play out the tragedy of the commons: a single patient's best interest is served by using an antibiotic in a way that potentially reduces its value for all future patients.

Lappé identifies all these difficulties, but he seems to lack a sense that it is possible to make honest mistakes, or that a viewpoint other than his own might be credible.

ILLUSTRATIONS: JEANNE FISHER

Instead, he turns groups of people into single entities (the pharmaceutical industry, the medical profession), and then implies that they have been criminally negligent or willfully villainous. For example:

"In 1950, with cattle and hog production at an all-time high, experts placed hope for further improvements in production on bettering their genetic stock. But additional help came from an unexpected corner—the pharmaceutical industry. Overinflated in usefulness and oversold to the medical profession, antibiotics were available in substantial excess in the early 1950s. By 1960, production was growing by 30 percent a year. Antibiotics had become a mass-market commodity without a mass market.

"The feedlot provided a ready market, as one large producer after another was sold on the often dramatic weight gains made possible by adding antibiotics routinely to cattle feed. Between 1950 and 1956, gains of nearly 5 percent over previous norms were commonplace wherever hog or livestock density was high enough to have caused problems of diarrhea and other conditions related to overcrowding."

The author's economic analysis in these two paragraphs is even more perplexing than his syntax. Was antibiotic production increasing at 30 percent a year without a corresponding increase in sales? If so, what possessed the "pharmaceutical industry" to exhibit such irrational behavior? Were livestock producers duped into purchasing antibiotics to bail out those wildly overproducing drug companies?

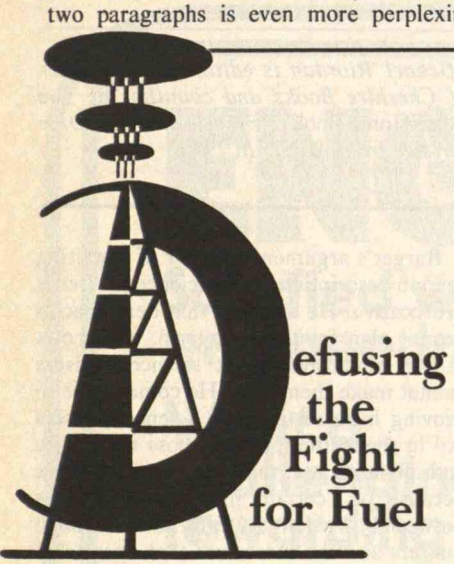
At its worst, Lappé's propensity for sloppy and exaggerated language leads him to misrepresent the problem. He implies that acquiring resistance to antibiotics also makes bacteria more likely to cause infection and to be more virulent once they have caused disease. This point, which he does not document, is probably based on a single report from Mexico City on gut bacteria that caused an outbreak of infantile diarrhea in 1976-77. In these bacteria, genes for antibiotic resistance had become linked on a plasmid to genes for a toxin that makes otherwise innocuous bacteria pathogenic.

But this is the only proven case of its kind. It is a serious warning but not yet sufficient basis for writing, "Our otherwise neutral intestinal bacteria, particularly the most prevalent form, *Escherichia coli*, have undergone rapid evolutionary change under the pressure of new hospital practices and antibiotic use, and some have changed into dangerous pathogens." Perhaps more misleadingly, Lappé also says, "A further complication of the story is the link that has recently been discovered between the genes for resistance and those for making some bacteria more virulent."

These samples of Lappe's rhetoric are representative of his whole book. From the (ungrammatical) first sentence of the acknowledgments to the (also ungrammatical) last sentence of the conclusion, *Germs That Won't Die* is written with the kind of careless hyperbole exemplified by its title.

It is regrettable that Lappe approaches his topic as a raker in search of muck. The problems of antibiotic use are real; they deserve the attention of the general public. A degree of political savvy and toughness will no doubt be required to solve them. But action should be based on accurate information and clear thinking, not shrill and simplistic polemics. □

William Bennett, M.D., is director of the Writing Program at M.I.T. With Joel Gurin he is author of The Dieter's Dilemma: Eating Less and Weighing More *(Basic Books, 1982).*



Defusing the Fight for Fuel

Energy, Vulnerability, and War: Alternatives for America
Wilson Clark and Jake Page
New York: W.W. Norton & Company, 1981, 238 pp., $5.95 paperback

Reviewed by Michael Riordan

Nazi Germany fell quickly to invading armies once the Allies began to bomb and decimate its "centralized" energy systems in mid-1944. But Imperial Japan—with an intricate, "decentralized" network of small hydropower installations—would have proved much more difficult to invade, had not twin atomic bombs convinced Hirohito to capitulate before a single American soldier had even set foot on Japanese soil.

So claim Wilson Clark and Jake Page in their book *Energy, Vulnerability, and War*, an intriguing analysis of the relationship between energy delivery systems and national security.

The book began as a Department of Defense (DOD) project led by Wilson Clark, author of *Energy for Survival*. As Governor Jerry Brown's energy advisor, one who played a critical role in developing California's policies for solar and renewable energy, Clark brought obvious prejudices to the project. Jake Page, a contributing editor and columnist for *Science 82*, helped Clark convert a dry government report of the same title into a fairly readable book, but the biases of the sponsoring agency persist. Its primary focus is on the steps the U.S. government and military (not the American people) might take to promote greater national security. These steps are based on encouraging small-scale, *decentralized* approaches to energy conversion and generation.

Clark and Page deal here with a question of vast importance, one that has received only scant attention until recently: To what extent would reliance on renewable energy sources contribute to world peace and stability? Certainly the current dependence of most industrialized and developing nations on Middle East oil does little to foster peace. Sooner or later these nations will have to cut back drastically on their energy consumption or battle one another for what little fossil fuels remain. By contrast, countries relying largely on indigenous, renewable energy sources would have less incentive to fight.

But, as the authors recognize, the issue of energy and vulnerability goes far beyond the mere question of imports. According to Clark and Page, our present centralized energy systems offer an inviting target for "limited" nuclear war—a topic currently in vogue in both NATO and Soviet military circles.

The book opens with a chilling dramatization of one such "limited" war, drawn largely from *The Effects of Nuclear War*, a report compiled by the congressional Office of Technology Assessment (OTA). In this scenario, submarine-launched nuclear warheads obliterate major oil refineries and other facilities that supply two-

thirds of our petroleum and half our natural gas. Like Hirohito, Reagan is forced to capitulate before even launching a counterattack, and America begins a decades-long process of recovery in a totalitarian world dominated by the Kremlin.

The authors contend that highly concentrated fossil and nuclear energy systems make such "energy wars" inevitable, that "as these systems become more rather than less centralized, they virtually *invite* attack." They also contend that a decentralized energy system based on renewable sources would make such "energy wars" much less likely, both because it would reduce imports and because it would offer few ready targets for enemy missiles.

These claims demand thorough analysis and substantiation. Unfortunately, Clark and Page fall short of this goal. The book reads like a hastily written and poorly edited adaptation of the DOD and OTA reports. Even a quick perusal revealed several errors of fact as well as editorial mistakes. Consider the following:

"For two decades, the Soviets have been bringing students to the USSR from Baluchistan, an area in Pakistan athwart the Iranian border. The southern border of this province is the Straits of Hormuz in the Persian Gulf, the narrow tunnel where a vast amount of Middle East oil makes its way to Japan and the West." A cursory glance at any map reveals that Iran, not Pakistan or Baluchistan, abuts the Straits of Hormuz.

A little later, we discover that there are "three basic ways to store energy: as heat, as electricity, or as kinetic energy." While I cannot recall many effective ways to store energy as electricity, any undergraduate physics student should be able to suggest a few more ways to store energy—as chemical, potential (gravitational), or nuclear energy—options not included in Clark and Page's list. Such errors convince me that haste, not care, was a major consideration in preparing this book. They make it very difficult to believe other statements not so easily checked.

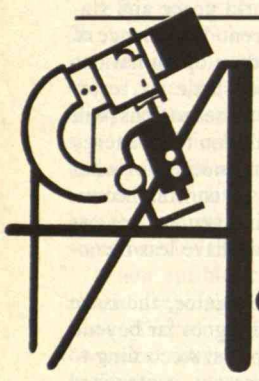
The second part of the book is a "catalogue of practical strategies and technologies" to help solve these security problems. Here the authors provide the usual discussions of energy conservation and efficiency, as well as solar, wind, biomass, and geothermal sources of energy. But a much better treatment of this subject can be found in *Energy Futures*, by the Harvard Business School Energy Project.

More refreshing would have been an analysis of the potential impact of dispersed energy systems on the U.S. defense posture. I was repeatedly left wondering about just how this or that alternative would actually reduce our vulnerability to nuclear attack. Only in the epilogue do Clark and Page return to their purported central theme, and there only briefly.

A haunting perception pursued me while reading this book: that so-called "appropriate" technologies based on renewable energy sources would be even more appropriate in a world devastated by nuclear war. Clark and Page allude to this possibility in describing America's recovery from the hypothetical energy war: "Energy conservation of all kinds was imposed by regulation: all new houses were better insulated than before, and most were fueled by alternative energy sources."

Renewable energies offer the very hopeful prospect that nations and societies can provide their own energy supplies and not battle one another for imports. But renewables will continue to struggle along as the neglected stepchildren of a fossil-fueled and nuclear-fueled world without more fundamental economic and political changes. The true "alternatives for America" begin with recognizing that the American people have no fundamental quarrel with the Soviet people. Rather, two massive, centralized military bureaucracies have emerged since World War II to threaten world peace and security. □

Michael Riordan is editor and publisher of Cheshire Books and coauthor of The Solar Home Book. *He received his Ph.D. in physics from M.I.T. in 1975.*



Advocate or Adversary?

Science at the White House: A Political Liability
Edward J. Burger, M.D.
Baltimore: Johns Hopkins University Press, 1980

Reviewed by William Lasser

Pity the poor presidential science adviser. The better he performs his job, the worse off he is. Though he tries to bring his analytical skills to bear on the nation's problems, writes Edward J. Burger, his very efforts cause him to be swept up in the dangerous vortex of national politics, with its illogical and uncomfortable processes of compromise, coalition building, and electioneering. The science adviser's attempt to impose rationality and planning on public policy, Burger concludes, "is rendered difficult by the very processes of democratic government."

How then should a science adviser spend the four years in Washington? According to Burger, he should resist the temptation to engage in "broad and systematic analysis for decision making and policy setting." He should reject this "science for policy making" task in favor of a role in "policy making for science." He should make "judgments about how much government money should be spent in support of research and development and how these monies should be allocated." He should be the advocate of federal support for scientific research, and should leave planning to the private sector think-tanks and universities.

Burger's argument in favor of rewriting the job description of the science adviser is provocative. He assumes that democracies cannot plan for the long term, and shows rather conclusively that science advisers cannot make them plan. He comes close to proving his assertion that science advisers fail in their attempts to impose rationality and planning on the democratic process because of "certain intrinsic differences between how scientists think about national matters and the incentives that operate so strongly on politicians."

That democracies cannot plan for the future is not news. Alexis de Tocqueville wrote in the 1830s that "a democracy finds it difficult to coordinate the details of a great undertaking and to fix on some plan and carry it through with determination." It would appear, therefore, that the reason science advisers fail in their attempt to impose planning is that no one could impose rationality on a democratic political system.

Burger claims, however, that scientists

have problems in the White House because their mode of thinking somehow provokes "the forces of rejection" to limit their influence. If he could prove this, his book would be a major contribution, for it would speak for science advisers who are not professional scientists, but perhaps lawyers and public-policy experts with scientific experience. But he does not provide such proof.

Burger's practical advice to science advisers is more interesting. They should confine themselves to making science policy, and to serving as advocates of science in the inner circles of power. This advice is particularly important in light of the views expressed by President Reagan's science adviser, George Keyworth.

Keyworth is a sort of David Stockman with a Ph.D. in physics. He believes in Reaganomics and he believes it can be applied to science. "My philosophy is in complete consonance with the president's," he has said. He is in favor of reducing federal expenditures on research and development, in keeping with his commitment to economic recovery as the nation's top priority.

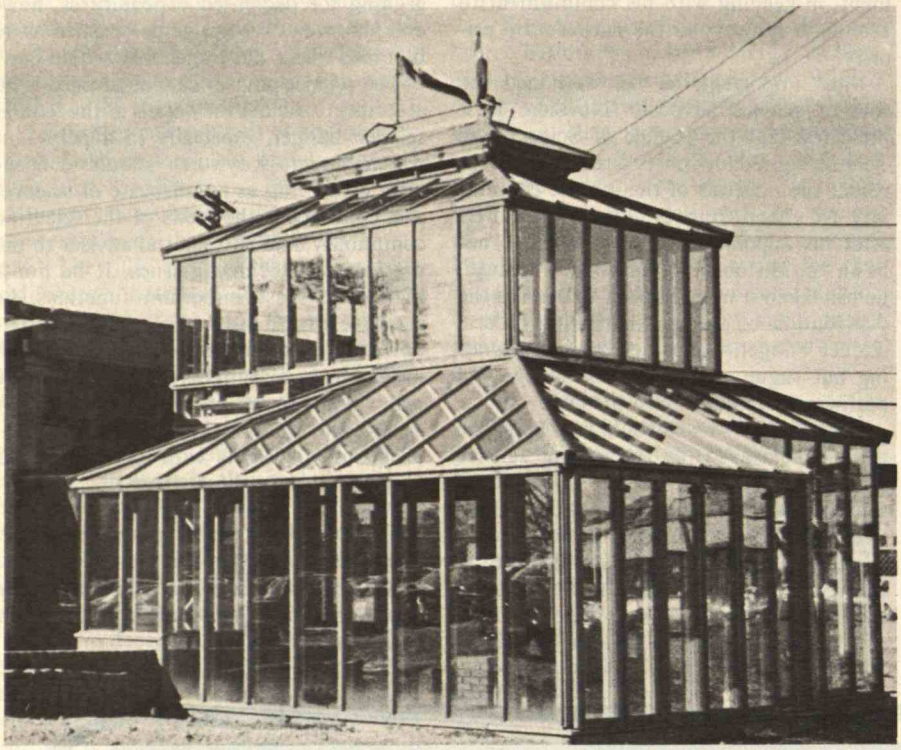
Most important, he has disdained the role of science advocate."Nowhere is it indicated that the [Office of Science and Technology Policy] or its director is to represent the interests of the science community as a constituency," he said shortly after his appointment. Keyworth will not be an "inside lobbyist" for science. Instead, he has taken it upon himself to oversee the distribution of the ever-shrinking federal science budget, using the objective-sounding but vague criteria of "excellence and pertinence" to aid him in the task.

Here Burger's book would help him. The science adviser's role in making science policy is directly linked to his role as science advocate. Burger considers these two roles as one. As long as the science adviser is arguing with his colleagues in favor of increased support for science, he can play a major role in how these funds are divided up. When the science adviser is arguing for decreased expenditures, however, his views are apt to be brushed aside by those whose pet projects he would cut.

The science adviser cannot succeed if he attempts to dictate the details of the federal science budget, especially in a period of retrenchment. Keyworth should concentrate on serving as an advocate of science, as a conduit for the views of the scientific community, and as a neutral adviser to the president on technical issues. If he limits himself to these important functions, he can have a substantial impact on the distribution of the federal science budget. If instead he persists in his present course, he may "find himself in waters dangerously close to the processes known as governmental planning." Many with good intentions have been lost in those waters. □

William Lasser is a Ph.D. candidate in the Department of Government at Harvard University.

M.I.T. REPORTER



The "crystal pavilion"—a new solar house design to demonstrate how the sun's energy can be captured for space heating even in a moderate, cloudy climate. The highly insulating double glass also has aesthetic potential, say the architects.

Glass under Cloud

A revolutionary solar house with glass all around—a veritable crystal palace—is now in operation on the M.I.T. campus. The idea is to collect as much solar energy as possible and so demonstrate that even where the sky is usually obscured by clouds, the sun can provide much of the heat needed by a small, single-family house.

And it works: on cloudy days during March, its first month of operation, M.I.T.'s sixth solar-heated building averaged 19°F warmer than the outside air, according to Timothy E. Johnson, principal research associate in the M.I.T. Department of Architecture.

Mr. Johnson is quick to explain, however, that this house is not intended for use in Boston. The idea is to test a solar heating concept appropriate to a climate such as that of the Pacific Northwest or England—with cool (but not bitterly cold), cloudy winters.

Mr. Johnson's design depends on the use of two technical innovations: special double glass that is highly insulating, and floor tiles that contain eutectic salt to store the heat that reaches them. Argon gas is used between the double glass sheets, and a transparent film of copper-tin oxide is applied to the outside of the inner glass sheet to act as a heat mirror. Together these innovations greatly reduce heat loss, and it's now clear, says Mr. Johnson, that solar heating can be economical in cloudy as well as sunny climates. □

Crisis in Student Aid

A massive outpouring of concern has greeted proposals by the Reagan administration to reorganize and substantially reduce federal aid to college and university students. These proposals are a serious threat to the institutions and their students and, in the longer run, the nation, say critics.

In a nutshell, the Reagan proposals would cut the Department of Education's $6-billion student-aid budget down to about $4 million in FY 1983. The first victims, affected in September 1982, would be graduate students who would no longer qualify for the low-interest Guaranteed Student Loans; they would have to borrow at substantially higher rates. A year later reductions in the Pell Grants—federal assitance to undergraduate students from middle- and low-income families—would be sharply cut.

Arguing especially against making graduate students ineligible for Guaranteed Student Loans, Paul E. Gray, president of M.I.T., warned in *Science* early this spring of "devastating" effects on the education of professionals. The result of withdrawing GSL supports will be reduced graduate enrollment, reduced resources in the universities for basic research, and "a reduction in our nation's capacity to innovate, to lead in science and technology, to compete successfully in international markets, and to secure our defenses."

It is paradoxical, Dr. Gray said in his editorial, that such mischief comes from an administration pledged to improving the nation's defense and strengthening its competitive position. □

Quieting Helicopters

That "slapping" sound of a helicopter rotor as heard from the ground is about to be conquered. It's caused by the interaction of a blade with the vortex left in the air by the preceding blade. The M.I.T. engineers who made the discovery are confident that blades can be redesigned and the "slapping" sound eliminated.

Though quieter helicopters are of interest to both civilian and military aviation, the methods used by James H. Hubbard, Jr., a doctoral candidate in mechanical engineering at M.I.T., may be more important than Mr. Hubbard's first result. The research involved novel instruments to detect and measure a boundary layer one-thirty-thousandth of an inch thick hugging the surface of a model helicopter blade—a phenomenon so small that many earlier researchers missed it entirely. The ability to detect such tiny air flows is likely to give Mr. Hubbard and his faculty adviser Professor Wesley L. Harris many important future assignments. □

Cleaning Water with Horseradish

Horseradish is the star ingredient in a new enzymatic system for treating industrial wastewaters.

Research by Alexander Klibanov, Doherty Assistant Professor of Applied Biochemistry in M.I.T.'s Department of Nutrition and Food Science, shows that perox-

idase—an enzyme found in horseradish—causes hydrogen peroxide to oxidize and therefore neutralize industrial pollutants.

In the presence of peroxidase and hydrogen peroxide, phenols and aromatic amines are thus turned into unstable molecular fragments—called free radicals. These in turn react with other molecules to produce even larger free radicals. Eventually these molecules—polymers—are stabilized and precipitate out of solution. Because they are nearly insoluble, unlike the initial chemicals, the polymers can easily be removed and separated by simple filtration or sedimentation.

Dr. Klibanov tested the horseradish derivative on waste from a fire-retardant manufacturing plant that contained more than 150 different chemicals, including 50 phenols. (Phenols and aromatic amines are toxic to most marine life, some are human carcinogens, and many are classified as "priority pollutants" by the Natural Resources Defense Council.) Carcinogens in the effluent were reduced to less-than-detectable concentrations, the water remaining was nonmutagenic, and the peroxidase appeared to be quicker and more efficient than the usual bacterial treatment.

This is because the method involves what Dr. Klibanov calls a combination effect. The removal efficiency of peroxidase is very high (up to 99 percent) for high-molecular-weight compounds that are easily removed, but the efficiency is only about 62 percent for lighter molecules that resist removal. But when peroxidase is used with a combination of the two, the heavy, easily removed pollutants actually facilitate the removal of the more stubborn ones. This happens because the free radicals that are formed first react with the lighter compounds to produce a mixed polymer that readily precipitates. Since industrial wastewater generally contains a mix of pollutants, this effect offers a real advantage.

In addition to the high removal efficiency, Dr. Klibanov cited three other advantages of the horseradish enzyme at a Sea Grant seminar early this spring:

☐ The final precipitate has significant value as fertilizer. (In processes such as bacterial degradation, the bacteria use the phenols for their own metabolism and produce only carbon dioxide.)

☐ Unlike bacterial degradation, which is biological and sensitive to cold temperatures, the horseradish reaction is chemical and can be used year-round.

☐ The cost compares favorably with that of other methods—depending on the price for horseradish, of course.

Dr. Klibanov admits that if the process is successfully transferred from laboratory to industry, the supply of horseradish—a seasonal product—may not be adequate. But he believes he has found a bacterium that naturally produces a peroxidase equally as effective as the horseradish enzyme. Grown in laboratories, the bacteria would offer an ample supply of peroxidase.—*Barbara Goldoftas* ☐

Auto Engine Research

A new industrial consortium will support engine and combustion research in M.I.T.'s Sloan Automotive Laboratory—fuel flow and combustion inside engines, the effects of changes in fuel quality, engine lubrication and friction, and engine and transmission systems.

Professor John B. Heywood, director of the laboratory, notes that rising energy costs and changes in fuel quality have stimulated rapid change in auto-engine technology, and "even more extensive changes are likely" in the future. He's confident that "an expanded engine-technology research base" will be "extremely valuable to the automotive and petroleum industries."

Charter members of the consortium include Caterpillar Tractor Co., Renault, John Deere Co., Cummins Engine Co., and United Technologies Research Center. ☐

Harbor Without Home

Alone of the major harbors serving U.S. seaport cities, Boston Harbor is an orphan. "Nowhere in Massachusetts is there to be found an agency, an office, or a visible group to focus on Boston Harbor as a place," writes Judith T. Kildow, associate professor of ocean policy. As a result, she concludes after a year-long study under auspices of the M.I.T. Sea Grant College Program, the harbor's "high potential for public use and revenue-generating activities" is underutilized.

Just one example cited by Professor Kildow: "Commuting by water between Boston and points on the South Shore, the inner harbor, and even the North Shore is held up *not* by technological limitations, *not* by financial limitations, *not* by space limitations, *not* by demand insufficiency." Rather it is held up "by simple lack of a commitment to the concept and its viability." Achieving the dream, as it's being achieved in San Francisco and other coastal cities, requires only "an open-minded, harbor-and-people-oriented administration," writes Professor Kildow. ☐

CLASSIFIEDS

PROFESSIONAL

CLASSIFIEDS CONTINUED

THE ACCESS GROUP, INC. Engineering Specialists Nationwide

All Levels-All Industries.
ALL FEE PAID-FULLY CONFIDENTIAL.
Contact-Bill Kan, Ph.D. '58,
P.O. Box 3267-111 High Ridge Road,
Stamford, Ct. 06905. 203-356-1168

EXP. OUTSIDE DIRECTOR

Senior Mkt Officer, former sr. EDP officer of $200MM NYC Mkt. firm available as director or Mkt/EDP advisory board member. MIT (Sloan), Harvard (AMP), etc.

Gateway, Box 2211, NYC 10163

PUBLICATIONS

This summer explore, using

PRECISE MAPS OF OLD WESTERN TOWNS

- Usage and outlines of buildings clearly shown on fire insurance maps from the turn of the century.
- Scale of reproductions 1:770; also available in 35mm microfilm.
- Write or call for ordering information:

Vlad Shkurkin, Publisher (415) 232-7742
6025 Rose Arbor, San Pablo CA 94806

"Observers of the infant satellite communication industry express optimism about its prospects. Yet, as the financial stake in satellites becomes greater, so too will the political pressure on those corporations using the space over the equatorial countries, territory claimed by these nations as their own natural resource."

SPACE JOURNAL
The First Newspaper of Space

To find out more about the commercialization of space, send $10 for a one-year subscription to: Space Journal, 350 Cabrini Blvd., N.Y., N.Y. 10040.

Pure Water

Send for **Free Booklet** on water quality and complete information on Pure Water Systems.

enclose $2 for the book "Water for the 80's: A cause for Concern"

Pure Water of New England
Box 296 S
Newtonville, MA 02160
(617) 924-0959

THE SPACE PRESS

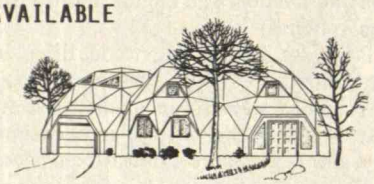
is a serious monthly 20pg report covering all facets of outer space affairs-scientific, technology, commercial, military, political, international, education, careers, etc. $15 yearly, or $7.50 ½ year trial sub. SPACE PRESS 645 West End Ave., NY, NY 10025

FOR SALE

THE UNIQUE FOUR-COLOR AUTOMATIC

ballpoint pen which writes black, red, blue, or green is $9.95. The superb combination of automatic pencil and ballpoint pen in one slim body is $8.95. These fine imported instruments feature the highest standards of quality, performance, and appearance. Send check or money order to ARCK Company, Dept. TR, P.O. Box 7039, Prospect, CT 06712

OWN THE STRONGEST, MOST ENERGY-EFFICIENT HOUSE AVAILABLE



Our innovative dome kit is easily built by owner or contractor, less expensively than a conventional house. Assemble precision cut polystyrene foam panels, and add steel-reinforced concrete to make super-strong, super-insulated shell. Seamless, will not leak, fireproof, wind loads 180 mph, snow loads almost limitless. Low maintenance, durable, attractive. Planning kit $4.00.

AMERICAN INGENUITY, INC.
401-T N. Harbor City Blvd.
Melbourne, FL 32935
=CREATING INTELLIGENT ALTERNATIVES=

TRS-80™ DISCOUNT DIRECT PRICES

Learn To "Do It Yourself" & Save

PURE RADIO SHACK EQUIPMENT

1-800-841-0860 Toll Free

MICRO MANAGEMENT SYSTEMS INC.
Parcel Division
DEPT. NO. 19
115C Second Ave S.W.
Cairo, Georgia 31728
912-377-7120 Ga. Phone No.

YOUR TRS-80 PERSONAL COMPUTER HEADQUARTERS
WRITE FOR FREE CATALOG

WANTED

INVENTIONS WANTED

Ideas, inventions wanted! Call 1-800-528-6050. In Arizona, 1-800-352-0458. Extension 831.

20% to 60% MILEAGE INCREASES

Distributors needed. NO RISK! 20% Residuals. Porter Associates PO BOX 454 Ironton OH 45638

REAL ESTATE/VACATION HOMES

NANTUCKET: INTERVAL OWNERSHIP

New timesharing for '82 in several very attractive locations, apartments, cottages and houses. For information contact the island firm with special experience and taste. David Webster, '50, Heard-Webster Assoc., Sparks Ave., Nantucket, MA 02554 (617) 228-4837

PARADISE/ST. JOHN VIRGIN IS.

Architect's secluded adventurous waterfront villa, Sullivan, Box HH, Truro, MA 02666 (617) 255-1084 days

RUSTIC CONCORD CONTEMPORARY

on over 3 private acres, with specially-designed cooking-entertainment center, 4 lofty bedrooms, 3 baths, oriented around atrium with swimming pool. A/C. $299,000.

PROFESSIONAL OFFICE ADJOINS

this Carlisle contemporary, on 8 divisible acres, with 5 bedrooms, 3 baths, barn with 3 box stalls. $219,000.

UNIQUE RURAL PROPERTY

in Lincoln, on a quiet country road, near major commuting routes. Sunny contemporary interior with large rooms and adaptable floor plan. Pastoral views—2.6 acres of lovely land. Eleven rooms, 2½ baths. $295,000.

BRIGITTE SENKLER & ASSOCIATES, INC.
18 Main Street, Concord, MA 01742
617-369-3600

TELLURIDE, COLORADO

Well appointed condominium in a scenic ski resort area slated for extensive future growth. One BR, one LR plus loft provide sleeping accommodations for six. Choice location near ski slopes and town center. $129,500. Contact Paul Blanchard (Sloan 1982), 503 Huron Ave., Cambridge, MA 02138. (617) 547-2458.

MOVING TO OR WITHIN HOUSTON?

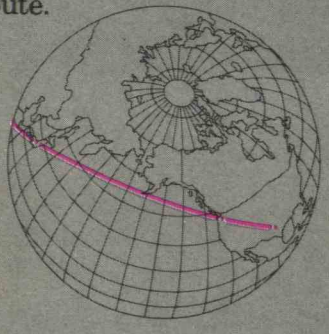
We can help you find the right place to buy or rent. For information, write to: Houston-Katy Real Estate, 20414 Laverton Drive, Katy, Texas 77450

HEARD ♦ WEBSTER
Associates, Inc.
NANTUCKET ISLAND REAL ESTATE
Residential, Commercial, Land, Rentals
David E. Webster '50
Sparks Ave., Nantucket, MA 02554 (617) 228-4837

Classified Ads: $7.00 per line, three-line minimum. (Allow 28 letters & spaces for first line, 50 letters & spaces for each additional line.)
Display Ads: $40 per inch — 3-inch maximum.
Copy Deadline: one month prior to publication date. Payment in advance of insertion required for less than three insertions in one year. Send orders to Classified Section, *Technology Review*, M.I.T., Room 10-140, Cambridge, Mass. 02139.

A people who would leave a water jar on their porch for a thirsty passer-by, need little training in the art of hospitality. This charming custom of Thailand has long been the children's chore.

A Thai stewardess begins learning her job as a child. The smile, the shy charm, the belief that life is meant to be enjoyed, is as natural to her personality as the languid gracefulness with which she moves her body. It is, simply, the Thai way. And, many say, the most enjoyable aspect of Royal Orchid Service on the "Great Circle Express" route.



A straight line from Dallas/Ft. Worth to Seattle, Tokyo, Bangkok. Shortening your flight by more than a thousand miles. (Perhaps, regrettably.)

Thai

A Flight of Graciousness.

It's not what you think it is. (But you're close.)

This Volkswagen Jetta is often confused with another well-known German car.

And not just because their lines are so similar. But because their personalities are so similar.

After all, both were designed for the serious driver.

And both were built to handle the toughest driving challenges Europe has to offer. From Alpine curves with no guard rails to autobahns with no speed limits.

Turn these remarkable cars loose on a really demanding road and they'll both respond: With rambunctious performance. Razor-sharp handling. And a rarely-equalled feel for the road.

All of which brings up a rather obvious question:

Why should you choose Jetta over the other car?

Well, the fact is that Jetta has a feature that makes it considerably easier to handle.

A considerably smaller price tag.

Nothing else is a Volkswagen.